

BRAZILIAN ETHANOL SUSTAINABILITY FORESIGHT¹

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ABSTRACT

This paper reports a prospective analysis effort on public policy demands for dealing with the impacts of the dramatically increasing demand for ethanol. The foresight exercise had the objective to point innovation demands for technological and institutional aspects relating to sustainability of ethanol industry as a whole. The prospective approach was specialist assessment and debate in workshop which issues ranging all decision levels, was organized in sessions: impact scenario, supply *net-chain* coordination; corporate governance; environmental management. We present a discussion on the results of the workshop, highlighting the desired public policies, identifying the lacks of knowledge on the main themes and suggesting a research agenda. This preliminary effort has to be validated in a policy roadmapping workshop. The main results consider that bioenergy economy increased opportunity: i) to provide sustainable regional development through the technology transfer yardstick; ii) to invest in R&D on the refinement of ethanol industry *net-chain* transactions, contracts and organizations; iii) to built a system of corporate governance and social & environmental responsibility that could signalize consumers, investors and government to rapidly pressure industry sustainability response; and iv) to promote the diffusion of certification of best environmental practices and the use of mechanisms for monitoring it from farm-mill to regional levels.

Keywords: Ethanol; Sustainability; Future; Public Policy; Foresight; Roadmapping

INTRODUCTION

Energy sustainability discussion on impacts from the renewable energy production expansion is being based on the promising scenarios for ethanol. It brings the need to understand these scenarios and to identify research questions toward ethanol sustainability, and to realize the role of public policies formulation.

This paper presents a discussion on the result of the "Research Workshop on Ethanol Sustainability", a foresight effort organized by the Institute of Agricultural Economics (IEA/APTA), within the research project "Public Policies Directives for the Ethanol Industry of São Paulo State", under the "Public Policy Research Program" supported by São Paulo State Research Support Foundation².

This essay is organized in five sections besides this first. The second section we present a brief description of ethanol industry trends. The third section brings a review on the state of the art of future studies methodology, specifically the methodology of foresight for public policy purposes, including the workshop formulation and operation. The results of the workshop are reported in the fourth section. In the fifth section we conclude on the threats/opportunities according to the

¹ This work is based on the results of the "Research Workshop on Ethanol Sustainability", organized by the Institute of Agricultural Economics (IEA/APTA), within the research project "Public Policies Directions for the Ethanol Industry of São Paulo State", under the Public Policy Research Program supported by FAPESP. We acknowledge the Workshop support from IEA/APTA, NIPE/UNICAMP and FAPESP, that allowed us to carry on the prospective assessment. The opinions and mistakes presented in this paper are all the authors own responsibility.

² Further information on this project and brief of partial results at the internet: <http://www.apta.sp.gov.br/cana>.

scenarios ahead and actual situation, and we list the gaps from the future desired to the actual situation, suggesting that a roadmap has to be validated in a forthcoming event.

ETHANOL INDUSTRY

Brazilian supply of ethanol increased from 1994 to 1998, when a crises period was beginning due to the high stock levels and low prices in domestic market. Following this period, the international market sugar prices increased. As a consequence, ethanol supply decreased in the domestic market, with decreasing demand, as total market share of ethanol engine automobiles decrease, from 75.5%, in 1985, to 0.06%, in 1997, with higher financial and fiscal costs. This picture inverted in 2001, when ethanol engines started been manufactured again and when the flexible fuel engine appeared in 2003. This event raised a new dynamics to the ethanol industry, with a promising scenario for a prosperous hydrated ethanol market. Several factors driver the increase of ethanol industry dynamism: professional management; contracts of short and long term; steady increasing demand in the domestic market due to flex-fuel engines³ and globally due to oil prices and Kyoto protocol.

The Brazilian sugar and ethanol sector harvested, in 2006/2007, 426 million tones of sugar cane, in 6.2 million hectares. Its production accounted to 29.7 million tones of sugar and 17.8 billions liters of ethanol, and the estimation for 2007/08 is 20.5 billions of ethanol liters. This will represent a participation of 41,8% in total global ethanol production, estimated in 49 billion liters. The estimative of sugar cane area expansion, in Brazil, represent more than double the actual area, in the next 10 years, accounting to 12.2 million hectares, in 2015/16, harvesting 902,8 million tones of sugar cane for processing, enough for titillating 36 billion liters of ethanol.

São Paulo State, in 2006/2007, cultivated 3.8 million hectares of sugar cane, representing 61% of national total sugar cane area. In the same year, it produces 61.5% of ethanol (10.9 billion liters), 65.8% of sugar and 61% of sugar cane from national total production. In 2007/2008, the outlook is a national production of 20.5 billion liters, and São Paulo would participate with 12.7 billion liters, about 62% of the total. In 2015, its participation would decrease to 54.9% due to availability and much lower cost of land in other regions. This widespreading, will have a positive impact on environmental pressures present in São Paulo State, although will depend on mid-west logistics for product transportation, as the Transpetro's ethanol pipeline project from Senador Canhedo, GO, linking Guararema, and from there, linking São Sebastião harbor, in São Paulo State. A nation broad expansion of the production is being zoned in studies for sugar cane sustainability concerning the lowest impact and with the exclusion of fragile biomes. Additionally, sugar cane production certification systems are already tested and available.

Global sugar cane ethanol supply is in expansion as other nations are wakening for this lower cost renewable fuel, while the United States are increasing the production of corn ethanol, with a higher cost. However, the drivers of this process of the global supply market is much more related to the amount of investments in science and technology for the next generations of ethanol production from many other sources of biomass. Therefore, the competitive advantage of countries that rely only in the availability of land and sun light and the actual ethanol technology is not guaranteed in the long run.

Nevertheless, the role of technology transfer for widespread sugar actual cane technology yet has the important argument of creating an ethanol international supply market, decreasing risks for traders and users. However, as history matters, global markets of many other agribusiness commodities have being developed along the last centuries and problems of supply (lack and excess), protectionism, and crises are still happening. But the increase of a renewable source of energy will be inexorable, as the investments in production, from he global agribusiness players: traders, logistic operators, mills corporations, regarding mills acquisition, joint ventures and fusion strategies, obtaining advantages with knowledge, supply, economies of scale, market power, transaction costs reductions and risk management. There is a vigorous consolidation process, according to KPMG data. The top 15 conglomerate account to 40% of the cane production, and in the next few years only 10 groups they will be responsible to 60%. In 2006 there were 9 fusion and

³ According to data from The Automobiles Manufacturers National Association (ANFAVEA), from January, 2003 to June, 2007, Brazil accumulated 3.2 million flex-fuel vehicles, 128 thousands ethanol-only, against 4,1 million gasoline-only automobiles. From January to June, 2007, flex-fuel automobiles participate with 87.91% of market share and gasoline-only automobiles participate with 12.08%.

acquisitions of mills, and in 2007, 15 transactions occurred. As a result of this dynamic, the Brazilian domestic consumption for fuel hydrated and dehydrated ethanol, in 2006, was 14 billions, and the 3.6 billions were exported, and the remaining 1.4 billion were for industrial use.

PUBLIC POLICY PROSPECTIVE ANALYSIS

The literature of prospective analysis describes applications for science, technology and innovation planning, business strategies and governmental policy. The methodological path discussed in this section describes a broad range framework of techniques, highlighting linkages among them, which were used in the prospective ongoing process that will be described in the end of this section.

Prospective studies⁴ aims obtaining information for deciding about future events to anticipate and understand the drivers, potentialities, evolution, characteristics and effects of innovation processes, institutional and technological change [1,2]. Technological prospective exercises and its variety analysis tools can be an important instrument for focalization primary needs and identification of knowledge gaps to be filled by research institutions and therefore their resource allocation.

Foresight is a multidimensional process to understand the long term future drivers that have to be taken into account to policy, strategy, planning and decision formulations [3]. It uses qualitative and quantitative methods for monitoring signs and trend indicators of an evolving issue. Considers intuitive methods based on specialist assessment are more suitable and cover a broader range of applications in this approach [1]. Although, foresight *per se* doesn't define policies, it can develop visions about how the future could be built [4], and suits better when applied to policy analysis and its implications, helping policies to be more robust and flexible in its implementation according to time line and changing conditions. However, these foresight processes are increasingly complex and new techniques are being applied to decrease complexity in the foresight, by constructing roadmaps [5].

Roadmapping is a planning framework [6] been used by a broad range of purpose applications including to support strategic and long-range planning intra-organization, inter-organizations (industry), from the private sector science & technology driven to the state-owned companies and governmental policy agencies. It is a systemic approach [7] for a live monitoring instrument which provides a tool for linking the environment scanning with scenario planning [8] and other prospective techniques. It also links drivers' evolution and inter-relation on markets, products, technologies, knowledge, resources and policy development and implementation in a time line. A policy roadmapping process can deal with different levels of future drivers: macro socio-technical transitions and institutional changes, industrial organization, supply-chain interaction and science organization. A roadmap can link these levels of analysis to business/industry sustainability threats and opportunities and the policy formulation agenda. It also links impact analysis and rank the eligible paths according to the evolving future.

In the case of public policy formulation roadmapping process, the knowledge flows are of two types: one "pull" driven process, in which requirements of knowledge and research are identified and resources are allocated for a long term problem solving approach; other is a "push" driven process where knowledge and capabilities are allocated to influence and establish the policy formulation process and content for a short term problem solving approach.

The classification by families of prospective methods that are described according to their refinement, information availability and treatment [9]. *Creativity* is a technique for knowledge interaction and generation of a great volume of new ideas. *Specialist panel* detects tacit knowledge and weak signs, therefore, it brings ambiguities and is used when information can't be quantified or modeled. *Monitoring and intelligence systems* are sources of pre-organized information for identifying critical trends and events, their relations, opportunities and threats. However, it provides a great quantity of information from several sources, and when poorly managed, it can result in non-systematized, non-analyzed, non selective information excess. Scenario aims to build alternative future pictures, analyzing dominant trends and disrupting possibilities, in a explorative or

⁴ Many similar perspectives have been described [1,4] as: the concept of *futuribles*, on Bertrand de Jouvenel, about the possible futures and strategies; the *Veille Technologique*, on Jakobiakand, about evolution and impacts observation and analysis for the identification of threats and opportunities of society development; *La Prospective*, on Michael Godet, who includes the desired future as a normative approach; and the *Technology Future Analysis* (TFA), more integrates technology foresight and assessment studies, predominantly, in the public sector, and integrates technology forecasting and intelligence, more related to the private sector.

normative approach. *Evaluation and decision* are methods to decrease uncertainty complexity when multiple interests and dimensions are being taken in account. *Participative methods* have become the key of prospective processes due to the application of its implicit democratic approach, conferring social legitimacy to results and have the ability to involve a diversity of participants, creating collective arrangements, searching for harmonic decision and implementation process. Other important major aspect is the fact that the knowledge construction has more effectiveness when there is interaction of knowledge dispersed among participants of an innovation process, and strategic information is widespread among key people involved. Due to these characteristics, they have an interesting appeal on methodology management. *Impact assessment*⁵ can be complementary when this activity is based on scenarios built by the prospective phase. Therefore, prospective analysis is fundamental to promote the ability of organizing innovation systems to have instruments for bringing concrete elements to subsidize decision makers. The exercise presented in this paper follows the scheme in Figure 1.

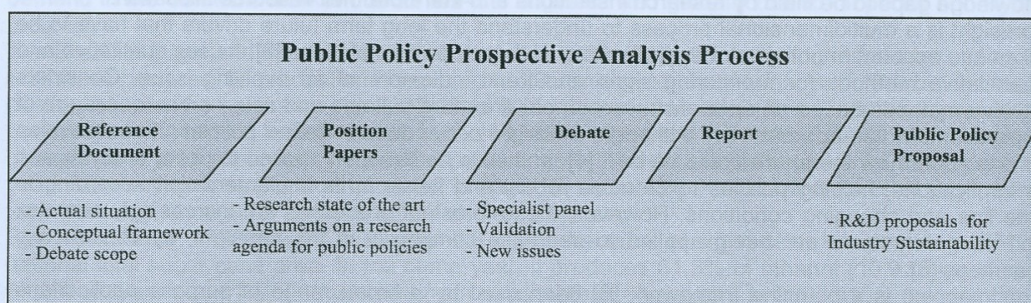


Figure 1: Ethanol Sustainability Research Workshop: a foresight for public policy.

This prospective effort, object of this paper, relies on several techniques for building an approach with elements of creativity, specialist panel, scenario and participation, regarding a starting point from a reference document, which was prepared for the delimitation of the scope, identification of the main issues, and definition of levels of analysis. The Workshop methodology was a four step procedure.

First, a reference document was prepared by the workshop coordinator, organizing four main areas of discussion on ethanol sustainability: impact scenario, supply *net-chain* coordination; corporate governance; environmental management, by and large crossing over all decision levels within different dimensions: economic, social, environmental and knowledge, that were simultaneously considered pervasive to several decision levels: the resource employment and allocation; the relevant role of institutions and organizations, property rights, regulation and the state; including the social tissue and the cultural factors. In the reference document, background themes were highlighted to keep the character of the academic discussion on sustainability indicator systems; its implications for regulation and managerial decisions, and methodological and conceptual vacuums. The concept of supply net-chain management and coordination, industry governance and strategic vision, the prospecting of institutional innovation and the proposition of science, technology and innovation public policies were also emphasized. As a result, the workshop was structured in four panels: 1. Bioenergy scenarios and the impact from sugar cane expansion; 2.

⁵ Impact Assessment methodologies are important tools applied to public policy internal evaluation and to the perspective of industry competitiveness as a function of science, technology and innovation. Both perspectives converged to the evaluation of technological programs. The economic impact uses production function, investment analysis, and consumer/producer excesses, but ignores the innovation process, its externalities and linkages in the knowledge chain. Therefore, it is better applied to incremental technology impact assessment. Social Return rate estimates the benefits of the changes of interest to the consumer/producer, usually being difficult to operate its causal relation, although implicit, is not direct. Direct Result is based in science metrics and bibliometrics, patents, licenses, inventions, *royalties* and sales. This method has the problem of the attribution. The technological path describes the institutional nuts and bows, linkages in knowledge chain, sources of funding, and collaboration nets.

ethanol supply-chain coordination; 3. Ethanol industry governance; and 4. environmental management.

Second, a list of specialists was prepared and invited to form panels of lecturers and debaters for each issue. Each lecturer was asked to prepare a position paper and submit to the debaters. Each panel accounted to one lecturer and two debaters, totaling four position papers: [10, 11, 12, 13]. Therefore, the workshop was organized to create the necessary atmosphere for the debate of ideas on the focus of ethanol sustainability problems, based on scenarios stated. It poses the relevant role of institutions and organizations to the coordination of mechanisms which imply on ethanol sustainability, highlighting the importance of transactions along the supply-net/chain, that produce relevant mutual signals to both directions of it, and their ability to direct decisions facing the sustainability tradeoff.

Third, a diverse group of hard and social sciences specialist researchers on ethanol industry was invited for contributing to the debate.

Fourth, at the event several proposals of research issues and policies were stated and documented.

RESULTS

The discussion's results indicate a general trend of ethanol industry positioning for the future global bioenergy market dynamics. Sugar and ethanol processing complementarities and alternative markets benefits the sector, although it is in a new dramatic expansion wave, it demands impact assessment studies regarding balance among environmental, social and economic issues with focus on regional analysis and territorial planning. The state role was identified as regulator of national policies and mediator for policy implementation, restricting or promoting the sector for sustainable development, regarding regional characteristics. It also realized that the sector must develop efficient incentive systems to signalize and foster value creation by the means of best practices in sector organizations towards sustainability, in addition to, better interaction among the several actors dedicated to science, technology and innovation processes.

Five major issues were identified:

- i) The dramatically increase of global demand for ethanol as a gasoline component in developed countries. It imply the opportunity for a national new development model, based on bioenergy and co-products economics, by the means of territorial planning, organizing clusters assisted by a governmental program for sugar cane ethanol knowledge and technology transfer to other Brazilian regions;
- ii) The sugar cane production rapid expansion has severe impacts in several regions changing the social, economic and environmental conditions, demanding deeper studies to assess and decide regionally the territorial plan of land use and sustainable social development. This other evident state role for national and micro regional policy implementing and mediating, is important for assuring sustainable efficiency of production for the environment and society;
- iii) The signalization systems for corporate governance, social responsibility and environmental certification, in the markets which finance the ethanol industry, be it capital markets, governmental loans, or end users, have to be efficient to foster best practices for the value creation for all interested in ethanol and those who are targeted by its impacts;
- iv) There is also the necessity of better articulation among the several organizations in the sugar and ethanol innovation system, what includes research funding agencies, private investors, governmental science corporations, and the production sector;
- v) The ethanol supply-chain coordination mechanisms are still lacking the enhancement of private instruments, from the farmers supply and marketing associations and their contracting with the mills organization, to the problems on market signals, the stocks management, the balance between the domestic and foreign markets, asymmetric information on product content due to adulterations, future markets and derivatives uses for risk management.

CONCLUSIONS

The ethanol increasing demand and sugar cane expansion trends lead industry positioning in order to supply the new global need of renewable energy. This event and its future development are being studied and were discussed in the foresight study presented hitherto.

Negative externalities and misbalancing were been posed as great future challenges for ethanol industry, and severe impacts can be seen in the future if no planning is put at work. Knowledge on

public policy to solve demands for dealing with property rights alignment with industry growth is of major importance. Studies on impact assessment with focus on deciding and territorial planning are the paving procedure for the opportunity for building a new concept of regional development based on spatially widespread bioenergy industry. The second pathway step, to support this last, is to increase the state role on providing R&D and technology transfer, investment on research for refinement of sugar cane farmers organization, contracting and transacting with mills through cooperatives. It means a high level technology transfer structure, not necessarily operated by the state, but promoted by a state policy.

Therefore, the role of the state in public policy formulation is obvious, but also implementation and mediation among different interests, regarding that state is never an unbiased solution. In this sense, a third step is the incentive of private mechanisms to promote best practices of corporate governance and social responsibility and refinement of these mechanisms and systems to make more efficient response from market and environment pressures.

Additionally, ethanol industry innovation system has to be organized for efficient resource allocation, with the maximization of competencies and its complementarities, consolidating the effort on planning by the means of the use modern techniques of foresight.

The methodology adopted in this work and the conceptual framework, were of fundamental importance for the results gathered, regarding the wide range of ethanol sustainability issues.

For future developments we suggest that these topics resulted from the exercise to be quantified, organized in indicators hierarchies inside their dimensions, monitored, keeping eyes on the linkages to the process of formulation and implementation of policies, in a time line for the long term. A roadmapping process would suit well for this purpose.

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