CROP PRODUCTION EFFICIENCY OF SUGARCANE IN THE STATE OF SÃO PAULO: II. SOCIAL AND ECONOMIC ASPECTS

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ABSTRACT: A useful application of the concept of crop production efficiency derived from thermodynamic is to evaluate the conjuncture aspects in regional scale, in order to identify the main socioeconomic factors that could affect the development or explain the stagnation of some agribusiness sector. Considering the real crop yield as the statistical IBGE database collect in different dates, it is possible to compare the socioeconomic conditions with efficiency, observing what factors promote it or cause the involution of some agribusiness sector. This paper intends to relate the variation of sugarcane crop efficiency with socioeconomic conditions in 1996 and 2003. In the State of São Paulo, it was possible to identify relationships between crop production efficiency and the soil variation, temporal price oscillation and the impact of technological innovations either in the agricultural, either in the industrial production systems.
KEY-WORDS: modeling, geotecnology, socioeconomic, environment,

RESUMO: Uma importante aplicação do conceito de eficiência da produção agrícola é avaliar como a conjuntura socioeconômica numa escala regional pode influir sobre o desempenho de determinado setor agrícola. Considerando o rendimento real igual aos valores disponibilizados pelo IBGE em escala municipal em diferentes datas, pode-se inferir sobre o grau e a forma de influência de fatores socioeconômicos sobre um determinado setor agrícola. Neste artigo, avaliou-se a eficiência da produção agrícola em duas diferentes datas, buscando analisar este contexto em 1996 e 2003. No Estado de São Paulo, foi possível inferir sobre a relação da eficiência com a variação temporal de preço, impacto das inovações tecnológicas e o nível de manejo empregados na cultura foram avaliados de forma qualitativa.
PALAVRAS-CHAVE: modelagem, geotecnologias, sócio-economia, ambiente.

INTRODUTION : Ecosystems can be compared to machines that use the solar energy to remain themselves organized. From the thermodynamics, the efficiency of any process can be expressed by the ratio between useful and available energy to realize the process. Monteith (1972) suggests that this approach could be also applied to improve the understanding of biophysical factors that intervene with the crop yield. Pinazza (1985) pointed that some factors can be grouped in four main classes. Among these classes, one could detaches is the socioeconomic characteristics because governmental and market actions could affect price, credit and commercialization.

To evaluate the effectiveness of the crop efficiency production, this concept was applied in an attempt to amplify the comprehension of the sugarcane agribusiness sector performance in the State of São Paulo along two different international and economic conjunctures, since the importance of sugarcane crop has been grown in last years in the context of the global

warming due to human activities, as good option of renewable and clean energy. The State of São Paulo is the main Brazilian sugarcane producer, representing more than 60% of Brazilian production ~~of Brazil~~. Beside the qualitative aspect, the sugarcane has an important social and environmental role in the agribusiness scenario of São Paulo, and has been cultivated a long time and several counties had been economic growth based on sugarcane.
The integration of crop growth simulation models in geographic information systems allows to the evaluation in geographic scale of the production and the diagnosis of the factors that exert restriction, in the cases of low efficiency, or that they determine high indices of efficiency.
The objective of this paper was to associate crop production efficiency of sugarcane in the State of São Paulo with socioeconomic parameters, aiming to identify some variables that could be used in zoning studies to qualify the regionalization of aptitude of sugarcane in regions where the crop must be expanded in the next years.

MATERIAL AND METHODS: Brazilian Institute of Geography and Statistics (IBGE) was the source of sugarcane production data of each county of State of São Paulo in the harvests 1995/1996 and 2002/2003. These harvests were select here because it represents two different social and economic conjunctures of the sugarcane agribusiness in Brazil. Counties production data were converted to observed yield (YO) by dividing it by county harvest area in each year. To assess the potential (YP) – maximum yield without any restriction element - and real yield (YR) – estimated yield considering the effect of water deficits on crop yield - of sugarcane in the State, it was used the agroecological zones method (Doorembos & Kassan, 1979).
To check the influence of abiotic factors on sugarcane crop efficiency were applied two different statistical tests . For soil, Spearman rank correlation coefficient (Snedecor & Cochran, 1982) was used to compare counties efficiency values where meteorological stations were installed with soil agricultural aptitude for sugarcane (Ramalho Filho & Beek, 1995). The non-parametric Spearman test was chose because soil aptitude is a discrete value, ranging from 1 to 5, according to soil quality degree available to sugarcane production, considering the environmental and economically sustainability.
To establish the relationship between climate and efficiency values it was not possible to apply a simple statistical method. Since YP and YR was assessed by agrometeorological models based on climatic data, a strong auto-correlation would occur in this case, invalidating the posterior inferences. Thus, to analyze the role of climate on sugarcane efficiency, the Pearson coefficient was applied in attempt to found how efficiency changes for a given change on climate conditions, when it is being represented by YP (Snedecor & Cochran, 1982).
The socioeconomic data base was constituted by different data types obtained from different fonts. Sugar mills spatial distribution was accessed in Sugar Cane Industry Union (UNICA) and Bioenergy Producers Union (UDOP) websites by assuming the geographical coordinates of the each county where the mills was installed. By literature review it was possible to find some important elements to establish the qualitative relationships with temporal and spatial variability of sugarcane efficiency. The amount of fertilizers and the price variation were obtained from public web service of Brazilian government.

RESULTS AND DISCUSSION: To analyze the evolution of sugarcane crop efficiency is important take in account the context of sugarcane agribusiness in the 1990 and 2000 decades. The rise in the correlation between efficiency and climate conditions between two harvests (Table 1) could be related to the increase of sugarcane plantation management investments, which seems to be a consequence of price elevation of sugar and ethanol in national and

international markets (Cesar, 1998; Vian 2003) and the advent of bi-fuel vehicles in Brazil in 2002. While during the 90´s year the ethanol-moved vehicle were almost eliminated of Brazilian market and sugar prices were not high enough to keep sugarcane agribusiness vigor such as observed along 80´s decade, after 2002 this scenario was deeply modified. International factors lead~~ing~~ the prices of petroleum and derived fuels to reach the higher historical values. At same time, the worldwide dissemination of ideas regarding the environmental conservation and especially ~~about~~ the global warming (Johnson, s/d; Johnson & Arvidson, 1999) were other important factor contributing to impulse the renewable fuels production, specially ethanol. In Brazil, one can see this pattern of variation efficiency strongly related to the high technology available to support this strong rise in ethanol demands and also the re-alignment of private sector in order to get competitiveness without government financial support and inserted in free market rules (Vian, 2003).

The difference between two Spearman coefficients in Table 1, defined by Marin et al. (2007), leads to infer about the sugarcane plantations and can respond more expressively to soil quality when other factor acting on vegetative development and yield formation phases are controlled. In other words, ethanol conjuncture conditions in harvest 02/03 were much more favorable than in 95/96, explaining the strongest response to soil in the first one, since fertilization can correct nutritional limitations of soils, minimizing the difference between best and worst soils. Considering all agriculture activities – not only sugarcane – it was observed that along the harvest 95/96 total simple fertilizer acquired by final consumers in Brazil was 10.8 million tons, while in 02/03 it reached 22.8 million tons (BRASIL, 2005).

Here, it is important to emphasize that all comparison were only made for counties that had sugarcane mills installed, in order to eliminated the variation component due to the presence or the absence of mills. Considering the logistic conditions of São Paulo, it is economically viable to transport sugarcane at maximum of 70 kilometers (Teramoto, 2002). In 2005, there were 134 sugarcane mills installed in São Paulo (Figure 1), with high growth rate from 2000 to 2005 (Santos, 2005). In spite of difficult to obtain the installation date of each sugarcane mills, it was possible to infer the major part of mills installed in the west region was done before 2000. Vian (2003) shows that major part of sugar mills and alcohol distillers were been installed in 1980 decade, with incentives and subsidies by Programa Nacional do Alcohol (Proálcool).

Table 1. Spearman (soil variability) and Pearson (climate variability) coefficients, and number of point used to evaluate soil and climate influences on crop efficiency in the two sugarcane harvests.

Harvest	n°. points	Spearman Coefficient	Pearson Coefficient
95/96	62	0.435	0.08
02/03	103	0.357	0.18

This little historical issue is important to establish the relationship between the development (or the involution) of some agribusiness sectors and its determinant factors, since socioeconomic and crop management factors would explain about 50% of the sugarcane efficiency variability in São Paulo State, mainly expressed throughout sugar, ethanol and petroleum prices, responsible for 50% of the spatial and temporal variation in São Paulo – and possible for other Brazilian regions. This kind of information is especially important to determine the classification of homogeneous regions in agroecological zonings, in function of difficulty to find any indication to establish the relative weighting of soil and climate layers.

It is important, also, to project scenes of long stated period because the relative weighting of climate and soil on crop is largely affected by the socio-economic conditions, especially those

regarding to price and commercialization of sugarcane and petroleum derived products. In the case of sugarcane, the relationship between crop efficiency and socioeconomic conditions indicates that a promising market scenario promotes a greater use of natural resources, since crop production efficiency showed an important rise when conjuncture became favorable to sugarcane producers.

Between the 1996 and 2003, the mean efficiency increased 4 percentile points and total production reaches 228 millions tons, representing a net gain of 35.6 millions tons since 1996. This increment, in turn, was partially due to an area expansion of 324.400 ha which gives 25 millions ton (70% of total production gain), and due an increase of crop yield about 4 t/ha, which results a total production increase of 10.6 millions tons (30% of total gain). In this approach, aspects involving technological innovation may be also inserted as an important way to increment efficiency by the adjustment of technologies in the sugarcane production system, from field to mills. In this paper, one focused only agricultural efficiency, but it is clear that industrial context is equally (or more) important. Even though the impact of sugarcane expansion on the food production or familiar agriculture it was not analyzed here, the efficiency rise by technological improvement can take an important role to minimize the expansion pressure on the regions where sugarcane still not reach and the negative effects that may be derived that disordered expansion. In an attempt to evaluate this question under an environment point of view, one can infer that in Brazil crop efficiency rise can became an interesting strategy to avoid the dangerous expansion of sugarcane areas since would not be necessary to implement new sugarcane areas to increase ethanol production. This sector seems to be especially sensible to quick innovations that could improve that quality of process used in sugar mills and crop field in respect to the environment sustainability (Embrapa, 2003). Table 2 shows the changes in the efficiency classes between the two dates analyzed; from such changes it is possible to infer that that an increment of one percentile point on mean efficiency rate in São Paulo State would represent an increase about 2 million tons of sugarcane. .

Regarding the social impacts of sugarcane expansion in Brazil, although there was a quite difference in the context, it is opportune remember the examples reported along the history involving the possible negative sugarcane effects such as observed in the Caribbean islands when the first sugarcane plantations arrived there (Furtado, 2007) and about the difficulties in sugar mills and cane producers in the history of sugar cane production in Brazil (Vian, 2003; Ramos, 1998). Despite Silva et al. (1978), however, reported environmental and social benefits related to the sugarcane agribusiness enhance along the Brazilian ethanol program – Proálcool, in other direction, Vian et all 2006 and Vian e Moraes (2005) showed that are a lot of problems to resolve work relations, social securities, and other thinks(Proalcool).

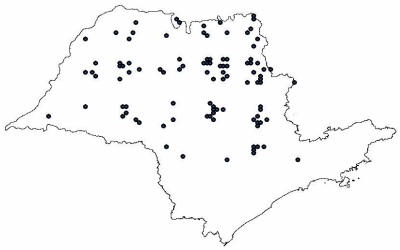

Figure 1. Spatial distribution of sugarcane mills in the State of São Paulo in 2005. Font: UNICA, UDOP.

Table 2. Area of sugarcane crop at each sugarcane efficiency production class in two harvests in the State of São Paulo.

Crop	Harvest 95/96	Harvest 02/03

Efficiency	ha	%	ha	%
0 – 10%	594.068	24%	632.528	22%
11 – 30%	407.175	16%	384.862	14%
31 – 50%	427.356	17%	398.451	14%
50 – 70%	894.584	36%	965.625	34%
> 70%	169.998	7%	436.139	15%
Total	2.493.180	100%	2.817.604	100%

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