Generation of Alcohol Production Scenarios as Support for the Formulation of Public Policies Applied to the Adaptation of the National Sugar and Alcohol Industry to Climate Changes

Scenarios can be described as instruments which aid decision-makers by providing a context for planning and programming, lowering the level of uncertainty and raising the level of knowledge. (Eleonora Masini, 1993).

Scenarios are not forecasts. They focus on relevant aspects and are challenging and meaningful images about the future.

Scenario Working - Morphological Futures Studies

Anita Rubin - Finland Futures Research Center, University of Turku

http://www.cost.eu/download/Thinking%20in%20Scenarios_Anita%20Rubin
Justification and Rationale

Why Study the Sugar Cane and Alcohol Sector? (1/4)

- High possibility that the Climate is changing and in the most drastic way (Scenario);
- Long time to develop techniques for mitigation and adaptation for Climate Change;
- Alternative for mitigation of GHGs and adaptation for Climate Change;
- Importance of agribusiness for Brazilian society and economy;
- Importance of sugar cane for São Paulo and Brazil;
- Traditional agricultural crop (~500 years of history);
- Adaptation is possible and desirable;
- Knowledge acquired and available in São Paulo;
- Costs and impacts of inaction can be very high (need of planning);
Different regional developments - Southeast, Northeast and Central West;

Great interest in the expansion of its production;

Production of food, energy, fuel and chemistry;

Can supply domestic and foreign markets, simultaneously;

Constraints against expansion - environmental sectors;

Competition with oil sector and other types of energy;

Typical factors of an agricultural production (seasonality, inelasticity, dependence of uncontrollable factors, such as the climate) - Stock;

Increasing use of technology;
Why Study the Sugar Cane and Alcohol Sector? (3/4)

- Use of large areas;

- Competition with other agricultural crops;

- Existence of different interests - e.g. population (fuel, food and environment);

- Development linked to several sectors (agriculture, industry, energy, environment, foreign trade, infrastructure, demography, food security, national and international policies);

- Risk of being a temporary solution for the climate change;

- Starting point of methodology well-defined, consolidated and used for several years in the definition of public policies in the agricultural sector;

- Great opportunity for business and development X Impacts (social, economical and environmental)
**Justification and Rationale**

**Why Study the Sugar Cane and Alcohol Sector? (4/4)**

Expansion

Constraints & Impacts

Potential, Pressure, Demand, Economical Interest, Land, Technology

Environment, Food Security, Tax Burden, Demographic Dynamics, Infrastructure, Human Health, Harvest Forecast

Great challenge to adapt a complex productive system for climate change

Public Policies

Production Scenarios
Future Scenarios for 2020, 2050 and 2070 - Sugar Cane - Brazil

Source: http://www.agritempo.gov.br/climaeagricultura/cana.html
Future Scenarios for 2020, 2050 and 2070 - Arabica Coffee - Center South Brazil

Source: http://www.agritempo.gov.br/climaeagricultura/cafe.html
Variation in production value in A2 scenario, compared to current IBGE values for 2006

<table>
<thead>
<tr>
<th>CROPS</th>
<th>CURRENT PRODUCTION (TONNES)</th>
<th>PRODUCTION VALUE (R$ 1,000)</th>
<th>IMPACT ON PRODUCTION VALUE BASED ON PRECIS A2 MODEL, 2020 (R$ 1,000)</th>
<th>IMPACT ON PRODUCTION VALUE BASED ON PRECIS A2 MODEL, 2050 (R$ 1,000)</th>
<th>IMPACT ON PRODUCTION VALUE BASED ON PRECIS A2 MODEL, 2070 (R$ 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>2.898.721</td>
<td>2.831.274</td>
<td>-313.422</td>
<td>-407.730</td>
<td>-456.401</td>
</tr>
<tr>
<td>Rice</td>
<td>11.526.685</td>
<td>4.305.559</td>
<td>-417.639</td>
<td>-530.445</td>
<td>-610.959</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>457.245.516</td>
<td>16.969.188</td>
<td>27.109.975</td>
<td>23.515.901</td>
<td>20.054.186</td>
</tr>
<tr>
<td>Sunflower</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cassava</td>
<td>26.639.013</td>
<td>4.373.156</td>
<td>-137.754</td>
<td>589.501</td>
<td>929.733</td>
</tr>
<tr>
<td>Maize</td>
<td>42.661.677</td>
<td>9.955.266</td>
<td>-1.192.641</td>
<td>-1.511.209</td>
<td>-1.720.270</td>
</tr>
<tr>
<td>Soybean</td>
<td>52.454.640</td>
<td>18.470.711</td>
<td>-4.357.241</td>
<td>-6.307.748</td>
<td>-7.645.027</td>
</tr>
</tbody>
</table>

Scenario s- Arabica Coffee - São Paulo and Goiás

1. INTRODUÇÃO

Reconhece-se o impacto do aquecimento global sobre a temperatura e a umidade do clima, o que tem causado alterações no comportamento climático, resultando em eventos climáticos extremos. Estas alterações climáticas têm afetado diretamente a produção de café, uma das principais exportações do país.

2. MATERIAL E METODO

O trabalho foi realizado em áreas de produção de café no estado de São Paulo e Goiás, utilizando metodologias estatísticas e de modelagem climática. Foram coletados dados climáticos e agronômicos com o objetivo de analisar o impacto do aquecimento global na produtividade do café.

3. RESULTADOS E DISCUSSÃO

Os resultados mostraram que o aumento da temperatura e da umidade do ar tem afetado negativamente a produtividade do café. Em São Paulo, o aumento da temperatura média anual foi de cerca de 0,5°C, enquanto em Goiás o aumento foi de cerca de 0,8°C.

Conclusion

Os resultados apontam para a necessidade de investimentos na pesquisa e desenvolvimento para a adaptação das culturas ao aquecimento global. A implementação de práticas agrícolas de adubação e irrigação segura é fundamental para garantir a sustentabilidade da produção de café.

Impacto das mudanças climáticas no zoneamento agroclimático do café no Brasil

Eduardo Delgado Assadi, Hilton Silveira Pinto, Jurandir Zullo Junior e Ana Maria Heilmann Ávila

Resumo – A partir das indicações de último relatório do IPCC (International Panel of Climate Change), foram feitos vários supormentos e avaliações que indicam um aumento na temperatura média da face da Terra, 1°C a 3.5°C e um incremento de 15% na precipitação pluvial, tendo na potencialidade da cadeia agrícola brasileira, definida pelo atual zoneamento agroclimático do café (Coffea arabica L), no Estado de Goiás, Minas Gerais, São Paulo e Paraná. Os resultados indicam uma mudança de sua aptidão para a cultura superior a 95% em Goiás, Minas Gerais e São Paulo e de 75% no Paraná, no caso de um aumento na temperatura de 2.8°C. Esses resultados são válidos se mantida as atuais características genéticas e fisiológicas das culturas de café arábica utilizadas no Brasil, que têm como limite de tolerância térmica média mensal outros 18°C e 29°C, assim como se mantido o regime pluvial atual. Portanto, para evitar a diminuição da produção do café, é necessário se tomar medidas de adaptação.

Keywords: Climatic change, agricultural zoning, Coffea arabica.

Introdução

A problemática das mudanças climáticas globais levou a Organização Meteorológica Mundial (OMM) e a UNEP (United Nations Environment Programme) a criarem o IPCC (Intergovernmental Panel on Climate Change) em 1988. Segundo o IPCC, no século XXI, haverá um aumento de 0,5°C à 1°C na média da temperatura global, sendo este mais pronunciado na década de 90. Quanto à precipitação, o aumento variará de 0% a 3% na região tropical, compreendida entre 10° de latitude Norte e 10° de latitude Sul. As causas dessas variações podem ser de origem natural ou antropogênica, ou uma soma das duas (IPCC, 2004).

Por meio de modelos matemáticos baseados dados registrados, o clima e a temperatura mediana global até o final do século XXI (IPCC, 2004). As magnitudes de tal previsão é ainda incerta e, portanto, deve ser tomada com cautela.

Climatic changes impact in agroclimatic zoning of coffee in Brazil

Abstract – According to the last report of the Intergovernmental Panel on Climate Change (IPCC), the global temperature is supposed to increase 1°C to 3.5°C and the rainfall 15% in the tropical areas. This paper analyzes the effect that these possible scenarios would have in the agroclimatic zoning of the arabic coffee (Coffee arabica L.) main plantation areas in Brazil. The results indicated a reduction of suitable areas greater than 95% in Goiás, Minas Gerais and São Paulo and about 75% for Paraná as the case of a temperature increase of 2.8°C. These results prove that all the physiological characteristics of the crop will be the same for the varieties analyzed and that the ideal climatic conditions for economic development are mean annual temperatures between 18°C and 29°C.

Index terms: Climatic change, agroclimatic zoning, Coffea arabica.

Scenarios - Arabica Coffee - Minas Gerais

Figura 2. Zoneamento atual do café para o Estado de Minas Gerais (A). Zoneamento considerando aumento de 1°C na temperatura e 15% na precipitação pluvial (B); Zoneamento considerando aumento de 3°C na temperatura e 15% na precipitação pluvial (C). Zoneamento considerando aumento de 5,8°C na temperatura e 15% na precipitação pluvial (D).

Agro-Ecological Zoning of Sugar Cane - 2009


http://www.cnps.embrapa.br/zoneamento_cana_de_acucar/
Agricultural Zoning - Ministry of Agriculture

Agricultural Zoning - Ministry of Agriculture

http://www.agritempo.gov.br/publish/zoneamento/SP.html
**Scientific Problem**

“Elaboration of ethanol production sceneries and the impacts associated, in the coming decades, in order to establish public policies that can promote the adaptation of the sugar and alcohol sector to the climate changes, considering their great social, economic and environmental responsibilities in the coming years.”

**Challenge**

“Consider, together, several factors directly related to the cultivation of sugar cane, to the production technologies of its main products (sugar and alcohol) and the impacts directly related to their performance (in the environment, in the food and nutritional security, in the demographic dynamics and in the human health).”
Production = f (Climate Model, 

Availability of Lands, 

Agricultural Technology, 

Genetical Characteristics, 

Population, 

Financial Resources, 

Politics, 

Infra-structure, 

Industrial Technology, 

...
Global Objectives

i. Generate scenarios for the production of alcohol obtained from a combination of the determinant factors of this production, for two representative regions in Brazil (one developed and another interested in expanding) in three different periods;

ii. Analysis of the adaptability of an important productive sector of the country to the climate changes;

iii. Assess the adaptation capacity of the society to the climate changes due to the complexity of the interrelations of the studied sector with political, economic, social and technical fields.
Specific Objectives (1/2)

i. Further the studies of impacts on climate change on agriculture - Coordination: A.M.H. Ávila (Cepagri);

ii. Evaluate the level of Food and Nutritional Security associated to the expansion of the sugar cane crop - Coordination: W. Belik (Nepa);

iii. Evaluate the impact of innovation policies to meet the future demands of ethanol and in the adaptation of Brazilian agriculture to climate changes - Coordination: A. T. Furtado (IG);

iv. Improve the harvest forecast of sugar cane, making it more objective and accurate - Coordination: J. Zullo Jr (Cepagri) - Link with AgrodataMine;

v. Estimate the evolution of the applied genetic engineering, mainly, to the sugar cane growing and the potential for industrial production of cellulosic ethanol - Coordination: A. P. de Souza (Cbmeg);
Specific Objectives (2/2)

vi. Evaluate the relationship between the expansion of the cultivation of sugar cane and the impact on urban and rural populations - Coordination: T. Aidar and R. Baeninger (Nepo);

vii. Develop methods for generating scenarios of climate change impacts based on data and information from several sources and having different characteristics - Coordination: J. Zullo Jr (Cepagri);

viii. Improve and deepen the scientific communication in the climate change area - Coordination: V. R. T. Camargo (Labjor/Nudecri);

ix. Examine the circulation of the scientific communication through existing public policies - Coordination: C. R. C. Pfeiffer (Nudecri);

x. Definition of public policies related to the expansion of the production of ethanol fuel in Brazil, due to the mitigation interest of the emissions of greenhouse gases, considering the need of adaptation of the national agriculture to the climate changes - Coordination: P. A. B. Schulz (FCA).
Results and Products in 2 and 4 years (1/2)

i. Scenarios for the production of alcohol for two representative regions in Brazil (one developed and another interested in expanding) in three different periods;

ii. Identification of three to five models for forecasting climate changes that are best suitable to Brazil and to impacts and vulnerability evaluations of crops to climate change;

iii. Evaluations of the climate change impact in the chosen test-areas;

iv. Identification of the relation between the expansion of plantations of sugar cane and the food and nutritional security;

v. Determination of the relation between the expansion of planted areas with sugar cane and the demographic dynamics;

vi. Effects of the modification of the atmospheric composition due to the use of ethanol fuel on human health;

vii. Deepen communications, for several different public, on the issue of climate change in multiple media;
Results and Products in 2 and 4 years (2/2)

viii. Effects of the various technologies available in the adaptation to climate change;

ix. Suggestion for public policies to the adaptation of the production of ethanol fuel to the climate change;

x. Better knowledge of the relation between the climate and the production of sugar cane;

xi. Improve of the accuracy, objectivity and anticipation of the harvests of sugar cane forecast methods;

xii. Evaluation of the utilization of the agrometeorological products available on the Internet, especially on the pages of Cepagri and Agritempo, by the farmers, managers and technicians of the sugar and alcohol sector;

xiii. Methodology that allow to integrate the several different knowledge with the purpose to achieve the overall objective of the Project;

xiv. Training of qualified staff in the area of climate change.
Connections - Examples

- Brazilian Model of the Global Climate System
- SCAF – Macro 1

Climate Models - Clusters

**Cluster 0**
- CNRM-CM3.0
- CSIRO
- ECHAM5
- ECHO-GFGOALS
- GFDL2
- HadCM3
- HadGem1
- MIROCmed
- MRICGCM

**Cluster 1**
- CCSM3
- GISSEH
- IPCM4

**Cluster 2**
- INCM3

M.Sc - Unicamp: C. Macedo Jr. - Fapesp 2009/07081-0
Technological Innovation and Organization in Agrometeorology: A study of the network system dynamics of “Agritempo”.


Use of agrometeorological models to estimate the production of sugarcane in Brazilian Savanna: Risks and Future Scenarios

B. A. Evangelista (Embrapa Cerrados) - PhD - Feagri/Unicamp - February/18/2011
Activities

- Three administrative meetings - December, February and March;
- Technical Meeting about Climate Modeling - Dr. Chou Sin Chan (Cptec/Inpe) - April/18/2011 - Nepo/Unicamp;
- Technical Meeting about Agricultural Zoning - J.Zullo Jr - May/26/2011 - 10h30 - Embrapa Informática;
- Technical Meeting about the Agrometeorological Service Agritempo - M.Bambino (IG/Unicamp and Embrapa Informática) - June;
Generation of Alcohol Production Scenarios as Support for the Formulation of Public Policies Applied to the Adaptation of the National Sugar and Alcohol Industry to the Climate Changes (AlcScens)

FAPESP Research Program on Global Climate Change - Process 08/58160-5

Summary

The theme of climate changes is no longer an issue restricted to academic area and became part of the everyday life of people and discussions subjects of national and international development policies, as the possibility of climate change is getting bigger in the most drastic way. Thus, the main approach recommended at this time is starting to develop ways, techniques and methods of adaptation of the human activities to these changes, because the costs and impacts of inaction can be very high.

The agriculture and the cattle raising, while activities that directly depend on environmental conditions for its performance, may be severely affected by the climate changes, mainly in tropical regions. This is worrying for Brazil because of the importance of agribusiness to the economy and to society as a whole. Among the agricultural crops of great importance for the country, the sugar cane has a special feature in the context of climate change due to the expansion of the use of alcohol fuel in Brazil and in the world, in the coming years, as a way of mitigating the emissions of greenhouse gases (GHGs).

There is, first, a great interest in the expansion of areas for planting sugar cane aimed at meeting the growing demands of alcohol fuel, whereas, on the other hand, several justified restrictions by the potential impacts on the environment, in the food and nutritional security, in the demographic dynamics and in human health and, also, the concerns about the effects of climate change on agriculture. This expansion should be properly planned, also considering, the adaptation to the climate changes, so that Brazil does not miss a great opportunity for business and development, but also, does not have economic, social and environmental damages because of hasty decisions and without the necessary technical and scientific basis.

This case shows that the great challenge is to adapt a complex productive system, with several inter-relations, to the climate changes, and as such will be handled in the Project by experts from several knowledge areas, such as, climatology, demographic dynamics, food and nutritional security, scientific communication, public policy, geo-processing, environment, human health and scientific and technological development. The tool to be used in the analysis on the capacitation of adaptation of the sugar and alcohol sector to the climate change and, in general, to the adaptability of the agribusiness as a whole, will be the scenery of the production of ethanol fuel and associated impacts.

http://www.cpa.unicamp.br/sugarcane_fapesp
http://www.cpa.unicamp.br/sugarcane_fapesp/ht
The great challenge of this plan is that it should consider, together, several factors directly related to the cultivation of sugar cane, to the production technologies of its main products (sugar and alcohol) and the impacts directly related to their performance (on the environment, in the food and nutritional security, in the demographic dynamics and in the economic health). Thus, in order to establish public policies that promote the adaptation of the sugar and alcohol sector to the climate changes, considering their great social, economic and environmental responsibilities in the coming years, the scientific problems of the Project will be the elaboration of different production scenarios and the impacts associated, in the coming decades, based on:

1. the various parameters involved in the production of sugar and alcohol;
2. the accumulated experience in the country in the sugar and alcohol sector, mainly in the state of São Paulo;
3. the availability of natural resources;
4. the development of agricultural and industrial technologies; and
5. the adoption of policies related to the sector.

4. Justification and rationale

The definition of the scientific problems to be addressed by the Project, based in the generation of a well-defined product (as should be the production scenario), was made with two main objectives:

i. Work for the adaptation to the climate change of a very important sector for the economy, known Brazil is the world's largest producer of refined sugar cane, with the state of São Paulo representing 48% of the domestic production and 63% of the world, and
ii. Create proposals concerning the realization of a deeper and more realistic analysis about the ability of adaptation of the main agricultural to the climate change and, in general, the adaptability of society and one of the greatest challenges that it currently has to think development.

The choice lies on the sugar cane, and the alcohol fuel, in particular, by the following main reasons:

i. The sugar cane is a very traditional agricultural crop in the Country, with nearly 500 years of history, considering that its production may exceed 300,000 hectares;
ii. The adaptation is possible (because it managed to overcome unfavorable moments along time) and desirable (due to its current and future importance for the economy of the Country); iii. There is a lot of acquired and available knowledge on the subject, mainly in the state of São Paulo;
iv. There are regions in the country with completely different developments (Santos and Northeast, for example) and some interested in expanding the production and development in the sector (Central West);

v. Structural to produce products with multiple purposes (food, energy, fuel and industry), unlike other crops that still do not have many variations of production (such as rice, for example) and that continues producing and exporting the same type of product for several centuries (such as coffee). The possibility of generating different products from the same raw material is an advantage for the industry, because its capacity of adaptation to the fluctuations that normally exist in the production area. However, this flexibility must be properly administered so that favorable situations for a type of product, in a given period of time, do not harm the other one. That has already happened in the beginning of the 50s in Brazil, when the increase of sugar production reduced the amount of ethanol that available to supply the national fuel that was not "flexible" and did not have the alternative of fuel fuel;
vi. In the supply, the domestic and foreign markets, disregarding, requiring a balance so that neither of them be damaged, when there are significant differences in terms between them, because both are important to the development of the sector;

vii. There is resistance in several sectors, especially in those related to environmental issues, with relevant limits to its expansion;

http://www.cpa.unicamp.br/sugarcane_fapesp/flip
Generation of Alcohol Production Scenarios as Support for the Formulation of Public Policies Applied to the Adaptation of the National Sugar and Alcohol Industry to Climate Changes

Process: 2008/58160-5 - Political Science (07090000)
Period: Dec/01/2010 - Nov/30/2014