BIOENERGY CONTRIBUTION OF LATIN AMERICA, CARIBBEAN AND AFRICA TO THE GSB PROJECT - LACAf-Cane-I

CONTRIBUIÇÃO DE PRODUÇÃO DE BIOENERGIA PELA AMÉRICA LATINA, CARIBE E ÁFRICA AO PROJETO GSB – LACAf-Cane-I

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Contents

1. Introduction

Modern and sustainable bioenergy production may be an effective way to substitute substantial portions of energy demand for transportation in the future. A recent study confirmed the potential for Brazil alone to substitute 10% of global gasoline demand in 2025 using sugarcane bioethanol (Leite et al., 2009).

According to Doornbosch and Steenblik (2007), 60% of the total world's potentially available land could be used produce bioenergy by 2050 (440Mha), of which around 60% (250Mha) will be in Latin America & Caribbean, and 180Mha in Africa). Since the availability of land for bioenergy will largely originate from pasture land, Figure 1 below gives an estimated by country based on data from FAO.

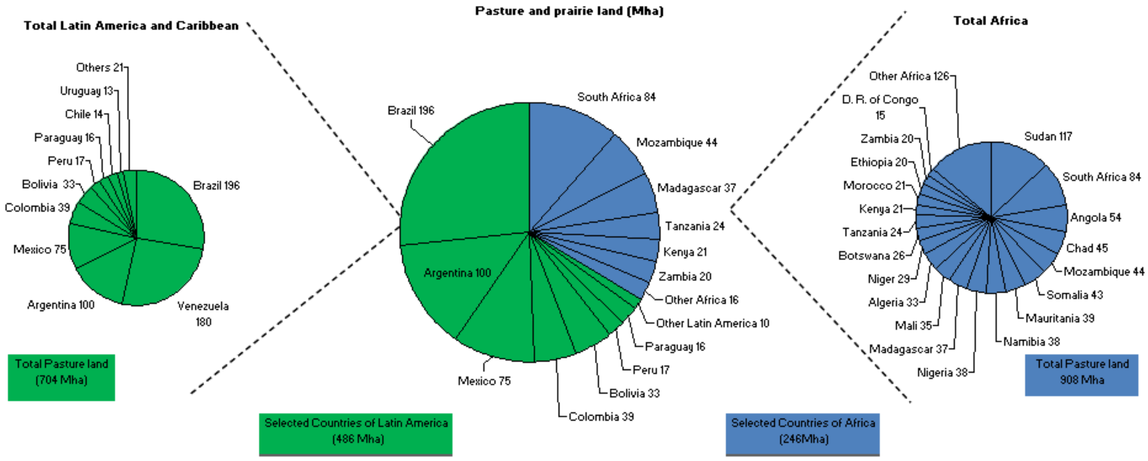

Figure 1. Available Area in Selected Countries of Africa and Latin America Source: FAO, 2008

The overall scale of bioenergy production will in part depend on the availability of fertile land with good climatic conditions, it is clear that, if food production is to be increased to meet future needs and biodiversity protected, basically the world will depend on the Latin America & Caribbean and Africa continents for future expansion of bioenergy.

The LACAf-Cane project will, therefore, focus in these two continents and will evaluate bioethanol production from sugarcane. Bioelectricity production from sugarcane will also be considered due to its important impacts on rural development and its synergy with ethanol production.

2. Programs to Encourage Biofuels Production

2.1 The Global Sustainable Bioenergy Project (GSB)[3]

The Global Sustainable Bioenergy (GSB) project was initiated in 2009 by a group of scientists, engineers, and policy experts from universities, government agencies, and the non-profit sector from across the globe, with the overall goal of providing guidance with respect to the feasibility and desirability of sustainable bioenergy-intensive future. In the summer of 2009, a statement on behalf of GSB project the organizers observed (Lynd, 2009):

"Although there is a natural reluctance to consider change, we must do so, because humanity cannot expect to achieve a sustainable and secure future by continuing the practices that have resulted in the unsustainable and insecure present."

Consistent with this perspective, the GSB project seeks to take a different approach from the many others worthy initiatives on bioenergy. Rather than focusing on what is most probable, the GSB project is focused on what is most desirable. Rather than reflecting often sharply divided expert opinion, the GSB project seeks to build new understanding and consensus. And rather than having the present as a point of reference, the GSB project concentrates on developing a sustainable vision of the future.

The core objective of the GSB Project is to test the hypothesis that ***it is physically possible for bioenergy to sustainably meet a substantial fraction of future demand for energy services (≥ 25% of global mobility or equivalent by 2050) while feeding humanity and meeting other needs from managed lands, preserving wildlife habitat, and maintaining environmental quality***.

Important features of the GSB project are:

a. To evaluate the <u>global</u> potential of bioenergy production;

[3] Lynd et al. A Global Conversation About Energy from Biomass: The Continental Conventions of the Global Sustainable Bioenergy Project. Interface (In Press). Submitted Dec 2010.

b. To consider several possible feedstocks, including sugarcane, switch grass, agave, miscanthus and other;
c. To make a long term evaluation, using 2050 as a horizon of reference.

The GSB project is structured to be implemented in three stages:

Stage 1(completed 2010). Hold five continental conventions with outcomes as follows:

a. endorse a common resolution about the importance of bioenergy and the goals of the GSB project;
b. gather input on structuring the analysis to be carried out in Stages 2 and 3;
c. approve resolutions representing perspectives on bioenergy, including key questions and opportunities, from each of the world's continents;
d. write a report encompassing a, b and c;
e. recruit participants and support for stages 2 and 3.

Stage 2. Explore whether and how it is physically possible for bioenergy to sustainably meet a substantial fraction of future demand for energy services – e.g. 150 EJ annually[4], corresponding to 23% of primary energy supply in the IEA Blue Map Scenario (2010)[5] -while feeding humanity and meeting other needs from managed lands, preserving wildlife habitat, and maintaining environmental quality. Answer the question: *Is it physically possible for bioenergy to meet a substantial fraction of future world mobility and/or electricity demand while our global society also meets other important needs: feeding humanity, providing fiber, maintaining and where possible improving soil fertility, air and water quality, biodiversity and wildlife habitat, and achieving very large greenhouse gas emission reductions that are not substantially negated by land use changes?*

[4] Total biomass energy in 2006 was 50 EJ of which 30 EJ was traditional biomass and 19.4 EJ was modern biomass. These values may be compared to total primary energy demand of 492 EJ (IEA, 2008).
[5] The 25% GSB goal was the preliminary target. In a more recent publication (interface paper) the GSB target was redefined.

Stage 3. Analyze and recommend transition paths and policies in light of Stage 2 results, incorporating analysis of macroeconomic, environmental, ethical and equity issues as well as local-scale effects on rural economies. Stage 3 also includes:

- Transition paths
- Enabling policies
- Economics
- Ethical and equity issues
- Local-scale analysis to validate, exemplify the vision developed in stage 2
- Rural economic development aspects
- Consequences for developing nations
- Commercialization
- Other important considerations identified in the course of the project

The GSB project has already conducted stage 1. Data for the 5 continental conventions held during 2010 (Table 1) is summarized at http://engineering.dartmouth.edu/gsbproject/. The full text of the Latin America (São Paulo) and Africa (Stellenbosh, South Africa) continental conventions may be found in the Annex and the remaining resolutions on line.

The next steps for the GSB project are stages 2 and 3. This project aims to contribute to these stages of the GSB project focusing Latin America & Caribbean and Africa.

2.2 Other Related Biofuels Supporting Programs & Studies

Another important program is the PRO-RENOVA[6] coordinated by the Brazilian Ministry of Foreign Relations – MRE to articulate government efforts, particularly in Latin America and Africa in the area of renewable energies.

The objective is to increase international scientific cooperation, particularly in these two continents. Two other programs from CNPq (PROSUL and PROAFRICA) can be used to finance the cooperation.

Other relevant studies to LACAf-Cane-I project:

[6] http://www.reporterbrasil.org.br/biofuel/exibe.php?id=120

1. Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa - COMPETE - SIXTH FRAMEWORK PROGRAMME FP6-2004-INCO-DEV-3 PRIORITY A.2.3.: Managing Arid and Semi-arid Ecosystems – September 2006
2. "Biofuels in Africa: An assessment of risks and benefits for African wetlands" Commissioned by Wetlands International – May 2008

Table 1. Summary data for the Stage 1 Continental Conventions of the Global Sustainable Bioenergy Project.

Continent	Location	Dates (2010)	Host Institution	Chairs	Sponsors	Number of Attendees
Europe	Delft, The Netherlands	February 26-26	Kluyver Centre for Industrial Fermentations	Patricia Osseweijer, Andre Faaij	Kluyver Centre for Genomics of Industrial Fermentation, Netherlands Organisation for Scientific Research; Delft University of Technology	70
Africa	Stellenbosch, South Africa	March 17-19	University of Stellenbosch, South Africa	Emile van Zyl	SANERI Chair of Biofuels; Stellenbosch University; National Research Foundation	40
Latin America	Sao Paulo, Brazil	March 23-25	The São Paulo Research Foundation (FAPESP)	Brito Cruz, Jose Goldemberg	FAPESP Bioenergy Research Program (BIOEN), Brazilian Academy of Sciences (ABC)	200
Asia, Oceania	Kuala Lumpur, Malaysia	June 14-16	Universiti Teknologi Malaysia	Ramlan Aziz	Ministry of Energy, Green Tech & Water	86
North America	Minneapolis St. Paul, USA	September 14-16	University of Minnesota	John Sheehan, Jon Foley	Institute for Renewable Energy and the Environment	64

3. “Biofuels in Africa: Opportunities, Prospects and Challenges” by Donald Mitchel
4. Studies conducted by CEPAL by Luiz Augusto Horta Nogueira and Waldir Gallo:

etanol: http://www.eclac.org/publicaciones/xml/9/14459/L606-1.pdf

biodiesel:http://www.eclac.org/cgibin/getProd.asp?xml=/publicaciones/xml/3/29423/P29423.xml&xsl=/mexico/tpl/p9f.xsl&base=/mexico/tpl/top-bottom.xslt

5. “General situation of energy in Africa”: http://www.jornaldaenergia.com.br/ler_noticia.php?id_noticia=4954&id_tipo=2&id_secao=17&id_pai=0&titulo_info=%C1frica%20demanda%20investimentos%20anuais%20de%20US%2493%20bi%20em%20energia

3. Objective

To discover and develop new knowledge related to the sustainable (social, environmental and economic) **production of sugarcane and other energy crops**[7]. We expect the results of the LACAf-Cane-I project (within the LACAf-Cane Program described in section 7 of this proposal) will contribute to the GSB Project goal, i.e., to sustainably meet a substantial fraction of future (2050) demand for energy services (≥ 25% of global mobility or equivalent) while feeding humanity and meeting other needs from managed lands, preserving wildlife habitat, and maintaining environmental quality.

The focus of the LACAf-Cane-I project is on **sugarcane and other energy crops. The produced feedstock is expected to be used for bioenergy: bioethanol (for gasoline substitution) and bioelectricity, both using advanced first and second generation technologies**.

Taking into account the national near-term potential of bioenergy production, energy dependence and experience with sugarcane agri-industry, an initial selection of countries was carried out as indicated below. Further analysis will reduce this group to a more workable set of countries for case studies, considering the time and cost limits of the current project.

Case studies (2 for each continent) will be defined as the project progresses based on: access to information (satellite images, data in general particularly important for the CTC and ICONE studies), strategic importance of the country, and possibility to establish partnerships. One possibility at this moment is to choose the country with largest sugarcane potential, and one country with a well established sugarcane industry presenting fossil fuel dependence. Most likely the case countries will be Colombia and Guatemala for Latin America and South Africa and Mozambique for Africa.

Brazil, Island states of Mauritius and Reunion will enter in the project as technology suppliers.

[7] The LACAf-Cane-I objective is also to evaluate possibilities from other bioenergy crops in the selected countries (Colombia and Guatemala for Latin America and South Africa and Mozambique for Africa).

4. The Context in Latin America & Caribbean and Africa

4.1 Latin American: current scenario and perspectives for bioenergy

Because of the growing concerns about greenhouse gas emissions, foreign oil dependence and the need for modern energy alternatives that contribute to rural prosperity, bioethanol emerges as a sustainable and renewable product with the capacity to replace a portion of global gasoline demand. The LACAf-Cane Project intends to contribute to the GSB Project, through its primary objective of forecasting the sustainable production of bioenergy (including social, environmental and economic aspects) in Latin America, Caribbean and Africa.

These tropical regions, as presented by FAO in 1997, have important natural conditions favoring bioenergy production, such as high solar energy incidence, appropriate temperatures, suitable soils and topography, especially between the parallels of latitude 35° North and South. In addition to water availability, there is potential for increasing arable lands and a tradition of sugarcane industrialization. In other research, Smeets et. al. (2006) showed that these regions have the greatest potential for energy crop production. Depending on the scenarios proposed by authors, potential energy production reaches from 90 to 280 EJ/year in Latin America and Caribbean, and from 50 to 350 EJ/year in Sub-Saharan Africa.

In parallel, the global bioenergy market is not well defined and most production and consumption of bioethanol is concentrated in a few countries. In fact, there are some barriers that hamper market development. In this general context, the following questions arise: (i) why, (ii) how much and (iii) how can Latin America and Caribbean produce bioethanol from sugar cane? To answer these questions, we have chosen countries where relevant data were available, such as: sugarcane production, available agricultural area, development of biofuels policy or government interest on biofuels. In Annex 2 are presented a brief explanation about the situation of bioenergy production in countries.

4.2 Africa: current scenario and perspectives for bioenergy

Africa is at a crossroads of trying to reconcile the conservation of its vast cultural and natural heritage with the many and increasing needs of a growing population. Powerful external forces continue to divert the continent from solutions that come from within, as they push for the privatization and industrialization of land, knowledge and biodiversity all in the name of poverty alleviation. The push for biofuels is the latest of these so-called "solutions" that is extensively promoted as an opportunity for Africa to develop energy security and alleviate poverty in rural areas.

The African continent produces 10.6 Mt of sugar and it consumes 16.1 Mt, so with its large land area and low cost labor, is an obvious target for biofuel developers. There is a high level of enthusiasm for these new developments, as African governments hope that biofuels initiatives will lift their countries out of poverty by providing the fuels and will improve energy security in Africa at the same time. In Annex 3 are presented a brief explanation about the situation of bioenergy production in African countries.

More detailed analysis of the energy and food security situation of Latin American & Caribbean and African countries are given in the "Documents" section of this proposal as ANNEXES I, II, and III.

5. Methodology - Project Activities

5.1 Regional diagnosis in Latin America & Caribbean and Africa & Integrated analysis

Research Team: Luiz Augusto Horta Nogueira[8], Manoel Regis Lima Verde Leal[9], Marcelo Khaled Poppe[10], André Furtado[11], Emile van Zyl[12]; José Maria Rincón Martinez[13]; Jean-Claude Autrey[14], Rodolfo Espinosa[15], Kafarov[16], Annie Chimpahango[17], Francis Yamba[18], Paulo Manduca[19], Laurent Corcodel[20], Frank Rosilo Calle[21], José Maria Silveira[22], Mauro Berni[23] , Lee Lynd[24] Leonard Sebio

Introduction

To properly assess the conditions to foster sustainable bioenergy production from sugarcane abroad, a crucial issue is the actual availability of resources for bioethanol production, facing diverse constraints and other demands. This assessment is more and more important, as the bioethanol production and use are evolving rapidly, with an increasing number of countries using ethanol as fuel while other are starting or planning ethanol production programs, using different productive routes, in many cases considering sugarcane as feedstock. Currently ethanol represents more than 2% of global energy consumption in the transportation sector and according to an IEA forecast, biofuels can represent about 50% of energy consumed to move people and goods in 2050.

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In scenarios of relevant ethanol production, sugarcane is clearly a crop of choice and many tropical developing countries are potential producers. In this context and in the framework of LACAF project, some basic concerns arise and should be carefully considered:

1. Why should Latin American and African countries get involved in bioethanol production? Is it important to increase energy self-sufficiency? Is there a potential conflict between food and biofuels production? Should a country produce biofuels to promote development or to take advantage in participating of the future biofuels global trade?

2. Once the previous question has been properly answered in each case it will have a reason to promote biofuels production. Then another question is: is there a physical potential to produce substantial quantities of biofuels for domestic use and/or exports? What is the current use of arable land in these countries? Are there enough natural resources (essentially land and water) to foster sugarcane production?

3. If there are good reasons and adequate physical near-term potential to foster ethanol production, the last question is: how can these countries implement the necessary actions? How is organized the government as regards bioenergy? How the energy/ agriculture/ environmental/ trade/ science and technology sectors operate and will react in the case of a significant ethanol production is put forward?

Of course that these questions are the starting point of many other questions and discussion, requiring detailed analysis and most of them will be object of different tasks and activities in LACAF project.

Objectives

As an introductory approach to the questions above, LACAf-Cane-I task Diagnosis of Energy and Food Situation in LA and AF & Integrated analysis will address fundamental aspects (environmental, social, technological, economic and institutional), taking into account the current situation and highlighting the most evident trends, in order to assess the current context to promote sustainably bioenergy from sugarcane.

Methodology

Considering regional and sub-regional data, as well as focusing particularly the four selected countries in Latin America and Africa (Colombia, Guatemala, South Africa and Mozambique), the following themes should be explored by literature surveys and stakeholders interviews, gathering data and information, eventually allowing comparative (benchmarking) and per country analysis, as well as, if the case, instructing preliminary public policies suggestions and recommendations:

a) Economy: GNP evolution and composition, agricultural commodities participation and trends in national trade, staple food export and import, financing conditions.
b) Energy: national energy matrix evolution and trends, energy prices and costs (mainly for liquid fuels and electricity), vehicular fuels demand and market structure, light vehicles fleet (number and age), energy dependence situation and concerns, regulatory framework and decision making processes.
c) Agriculture and agro-industry (with emphasis in sugarcane and sugarcane products): planted area, production, domestic demand, prices and estimated costs of main agricultural products, total arable land, irrigation requirements, agricultural inputs market, institutional aspects, research activities and resources, management and financing issues.
d) Environmental issues: general appraisal of near-term potential and perspectives of increase bioenergy production, legislation (including fuel specs and emission limits), institutions and decision making processes.
e) Social aspects: employment and wages indicators (rural and urban), HDI evolution and trends, public perception on biofuels programs.
f) Know-how in renewable energy, bioenergy and biofuels: outputs and lessons from previous experiences, projects and programs, human resources (technical and university levels), equipment industry situation and perspectives.

Such overall diagnosis will be useful for other LACAf-I activities, setting the stage for more detailed studies. In a complementary direction, this task will eventually incorporate outputs from other tasks, producing an integrated and more robust evaluation of ethanol from sugarcane potential and perspectives in each country, as well as the obstacles to be overcome and upsides to be explored.

Expected Results and Contributions to the GSB Project

An integrated diagnosis of current situation of several aspects concerning the expansion of ethanol production from sugarcane, with a general appraisal for Latin American and African regions and more detailed reports for four countries (Colombia, Guatemala, South Africa and Mozambique), presenting data and information on: main possible drivers for ethanol production, near-term potential for sugarcane production, domestic demand and trading perspectives, preliminary feasibility evaluation and environmental aspects.

Specifically as regards to GSB, this project will offer a close evaluation of actual condition for ethanol from sugarcane promotion in regions and countries where there is a good potential to foster this renewable energy in sustainable conditions.

5.2 Determining Land Use and Physical Near-Term Potential for Bioenergy Production in Latin America and Africa

Edgar Beauclair[25]

5.2.1 CTC: Sugarcane Production near-term Potential

Research Team: Fernando César Bertolani[26], Antonio Celso Joaquim[27] and Felipe Haenel Gomes[28], André Nassar[29], Fábio Marin[30], Heitor Cantarella[31], Alexandre Strapasson[32], Rubens Lamparelli[33]

Introduction

Any project of expansion or introduction of a crop in a country or region need to be linked with deep studies in areas such as the environment (weather and soil) to define the sustainable crop production potential. Inside this concept, the growth of bioethanol in the world will demand those studies that will be the basis for future taking decisions inside the bioenergy sector.

The study of the environment to set up sugarcane crops has to consider climatic, soil and topographic criteria. In addition to these factors, environmental preservation areas within each region should be raised and enclosed with the goal of establishing a better zoning for the crops being implemented. As a result of the combination of those criteria following a specific methodology results in a segregation of areas of different crop production potentials.

Objectives

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- Identify potential areas to sugarcane production in African and Latin American countries;

- Quantify the different production potential of sugarcane crops in these countries;

Methodology

a. Obtaining basic data

The basic information to be used for creating maps of yield potential will be raised locally in different countries. These information are maps of soil, climate, forest reserves and areas of environmental preservation. To access this information will be necessary to contact local governments, universities, research centers and non-profit sector from all countries involved.

A correlation of the international soils classification systems used in those maps (FAO-WRB[34] or Soil Taxonomy[35]) with the Brazilian soil classification system will be carried out, and then the sugarcane production potential will be determined for each soil group. Field trips to the regions to be studied will be carried out, at least one for each country, in order to recognize the inherent characteristics for each soil order classified in the available maps.

The available soil maps will be digitalized in the Geographic Information System (GIS) ArcGis® and of the slope maps will be generated from the one of the processed SRTM (Shuttle Radar Topography Mission)

b. Steps to obtain sugarcane production near-term potential, climate and soil environments

Forestry reserves and environmental preservation areas

The areas of forest or natural vegetation as well as environmental preservation areas shall be considered not suitable for the installation the culture of sugarcane. So even if they have potential for growing sugar cane will be removed from the planting area.

Soil Potential

The soils will be grouped in four different crop potential production (high, medium, low and unsuitable). The main characteristics used to fit the soils in those potentials are the

[34] FAO-WRB – The World reference base for soil resources of the Food and Agriculture Organization of the United Nations

[35] Soil Taxonomy – Classification system developed by the NRCS (Natural Resources Conservation Service) of the United States Department of Agriculture

natural fertility, texture and some peculiar characteristics of different soil orders, like effective depth, gravel presence, drainage and others.

Climate potential

The climatic types also will be grouped in four potential types (high, medium, low and unsuitable), being considered drought, temperature and the risk of frost. The near-term potential production will be considered with rainfed and with salvation irrigation.

Slope

Three slope intervals will be generated: less than 12%; 12-20% and above 20%. In the first slope interval there is no restriction to mechanical operations (transport, harvest and cultivation practices). In the second interval there are possibility of mechanical operations but with some restrictions and in the third interval (above 20%) there are several restrictions even for manual operations and it is considered unsuitable.

CTC (detailed chronogram)

Action	1st year				2nd year			
	1st trim.	2nd trim.	3rd trim.	4th trim.	1st trim.	2nd trim.	3rd trim.	4th trim.
Evaluations of areas and obtain data	X	X						
Creation of basic maps		X	X	X				
Field trips		X	X	X	X			
Creation of production near-term potential maps				X	X			
Preparation of reports					X	X		
Final Report						X		

5.2.2 ICONE: Land Use Change in Latin America and Africa

Research Team: Marcelo R. Moreira[36], Keith Kline[37], and André M. Nassar[38], Rubens Lamparelli[39]

Introduction

Agricultural activities have altered our planet's land surface and the production of agricultural feedstock for biofuel production may also have the near-term potential to change on land use in Latin American and African countries. Therefore, a comprehensive assessment of biofuel sustainability requires an analysis of the impacts that biofuel production will cause in land use.

Objective

The main objective of this analysis is to assess the land use impacts of biofuels production in Latin America and Africa. The specific objectives of this study are:

(1) Build a base map of land cover;
(2) Analyze recent land use dynamics and identify a pattern of land use change;
(3) Simulate land use change according to biofuel production scenarios;
(4) Evaluate potential GHG emissions due to land use change.

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Methodology

The methodology will require research in different areas of science, with both static and dynamic land use analysis. It can be disaggregated in four separate steps, according to the four specific objectives.

1. The first methodological step will focus on the construction of a land cover base maps, representing actual land cover. Some countries might have national statistics for land cover, but it is not expected that this will be the case for all countries, especially the least developed ones. Further, official land cover secondary data is generally incomplete, imprecise, and sometimes inexistent. The accuracy of land cover data is greatly enhanced when national inventory (secondary data) is combined with satellite-derived land cover data. The base maps for each country (or region) will be constructed using both secondary data and Geographic Information System (GIS) techniques.

The approach to merge those databases is described in details in Ramankuty *et al* (2008)[40]. The imagery required for this step is available in the Geo-Wiki project, a partnership of the International Institute for Applied Systems Analysis, the University of Applied Sciences Wiener Neustadt and the University of Freiburg.[41] Secondary database will come from official surveys and FAO data, according to its availability.

2. The establishment of land use change pattern is the objective of the second methodological step. Different from step 1, in step 2 we are no longer interested in a static portrait of land cover, but in knowing how land cover has changed in the recent past. This information will serve as the base to establish land use dynamic patterns.

The methodological approach will be based on Gibbs *et al* (2010)[42] that quantify agricultural expansion across the major tropical forests regions using Landsat scenes

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[40] Ramankutty, N.; Evan, A. T.; Monfreda, C.; Foley, J. 2008. Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochemical Cycles, vol. 22, gb1003, 19pp. (DOI:10.1029/2007GB002952)

[41] Information about the Geo Wiki project can be found at http://www.geo-wiki.org/index.php.

[42] Gibbs, H. K.; Ruesch, A. S.; Achard, F.; Clayton, M. K.; Holmgren, P.; Ramankutty, N.; Foley, J. A. 2010. Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. PNAS, vol. 107, no. 38, 16732-16737. (DOI 10.1073/pnas.0910275107.)

created by the Food and Agricultural Organization of the United Nations. This step does not depend on results from step 1.

3. Once step 1 and step 2 are concluded, we will have a base map of current land use (static) and identified patterns of land use change (dynamic). The additional information needed in this step is: the biofuel production target and the map of potential production of biofuel feedstock. The combination of the biofuel production scenario and feedstock potential gives the amount of additional land needed to meet the biofuel production target. The biofuel feedstock expansion and its effect in land use change will then be simulated according to the pattern of land use dynamics identified in step 2. It will then be possible to simulate changes in the actual land cover due to biofuel production.

4. Once step 3 is concluded, it is possible to calculate net CO_2 emissions/sinks from land use change. The methodology must consider CO_2 stocks above and below ground before and after land use change, as well as consider how those emissions are released over time. Here we propose to follow a tabular methodology (not an especially explicit model) to measure CO_2 emissions. The methodology used by the United states Environmental Protection Agency, for the Renewable Fuel Standard is described in EPA (2010)[43]. The impacts of biofuel expansion on the production of other agricultural commodities.

ICONE (detailed chronogram)

	1st quarter	2nd quarter	3rd quarter	4th quarter	5th quarter	6th quarter
Step 1						
Step 2						
Step 3						
Step 4						
Final report						

The beginning of this step depends on CTC finishes the potential study. It has to be decided also the production scenario for each country.

[43] United States Environmental Protection Agency (EPA). Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. EPA-420-R-10-006. February 2010 (www.epa.gov/otaq/renewablefuels/420r10006.pdf).

5.2.3 Use a Sugarcane Crop Model and Estimate Total Sugarcane Ethanol Production in LA and AF

Research Team: Edgar Beauclair[44], Fabio Marin[45], Heitor Cantarella[46], Alexandre Strapasson[47], SASRI[48], CENICAÑA[49]

- There are many ways of modeling a crop to estimate final production. The differences among them are related to the kind of parameters that are going to be used. More detailed models are willing to have a better understanding of the crop itself and its responses to environmental events and usually consider some parameters quite difficult to be obtained and to be applied for strategic and operational production planning like photosynthesis, transpiration and other metabolic and physiologic events in a micro scale in order to follows internal process in plant.
- A better approach for strategic planning goals are edaphoclimatic models that use parameters that are commonly obtained like type of soil, including its water retention capacity for an accurate hydric balance, historical series of whether records, specially rain and temperature and of course, some crop productivity under these conditions. Since in all cases the exact value of the parameters, the general model based on the theory of a system that converts the total amount of mass (water) and energy (temperature – degree-days) received into a productivity of the crop from that system. Much different conversion efficiency will be found and validation studies must be taken. The technological level is preponderant in increasing this efficiency, and the data cannot be extrapolated for different varieties, ages, soils, etc, but a general model can be done to be used as a primarily and conservative data, specially because the water retention capacity is going to be estimate and this will influence the hydric balance wherever methodology is going

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to be used. The crop coefficient (Kc) will be the FAO numbers that are very generic. The multiple regression analysis is the tool to be used in these studies. This methodology was able to predict this Brazilian season breakdown in April using the INPE climatic predictions and average numbers for different soils. It is far from perfection but it gives a nice base for planning the near-term potential production.

- Data mining (fuzzy models) doesn't seem to be an option in this case, since we believe that we already will face many problems to feed with reliable data any model.
- Another option is to buy "ready to use" systems like APSIM and CANEGRO. Again in these cases the systems must be feed with reliable data and they also need validation field trials, like all the others.
- For other crops we intend to use the same model and methodology, changing the crop coefficients for the proper ones from the same source that is FAO. They will have the same limitations described above.

5.3 Productive Models & Innovation Studies

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Introduction

In the development of the project of a new sugarcane ethanol distillery, the industrial sector can be installed already using the state of the art of the technology for cane processing to ethanol and energy generation. However, the agricultural sector has to follow the common practices in the initial stages, although it is highly desirable to have a program of progressive improvements and modernization, compatible with the farms skills and the ability of the government and private investors to introduce new and more efficient technologies. A tentative to make radical changes in the agriculture culture and practices will be doomed to failure since the agricultural sector, especially in developing countries, is a very conservative one and highly suspicious about the necessity and success of changes. Nevertheless, to be successful in the long term the feedstock production for biofuels have to follow the most efficient and sustainable practices since it has to fulfill certain requirements not normally demanded for food production. Energy efficiency, low lifecycle GHG emissions, high yields, low production costs are more demanding for energy than for food application.

Objective

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[59] USP/Brazil

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The objective of this topic is to determine the most important items and the corresponding road map that will conduct the sugarcane ethanol production technologies from the present stage to a desired stage of performance, bearing in mind the specificities of each country under consideration.

For that it is mandatory to select an ultimate production model that take into consideration the particular conditions of each country under consideration such as:

- Strongest driving force: energy security, GHG emission reduction, support to the agriculture.
- Agricultural production model: land tenure, size of properties, and level of local capacity, mechanization, main cultures and present agricultural practices.
- Impacts on food production: main staple food crops, land and water availability, planned biofuel production.
- Regulatory framework: biofuels support programs, renewable energy goals, tariffs for food and energy, support to biofuels R&D.

Methodology

Based on the preliminary analysis of the local conditions a production model will be suggested considering the existing local practices in agriculture and the desirable future agricultural technology, required to create a competitive biofuel industry and to maintain the social impacts on the positive side.

Therefore, the main issue to be considered in this development are:

- How to reduce the impacts on the present agricultural practices: maintain or improve the economic viability of small producers (analyze and adapt existing models in Africa and Brazil).
- How to improve the food production in the country: associate biofuel and food production in schemes such as cattle/sugarcane integration, use of greenhouses to produce vegetables using the resources from the ethanol distillery (electricity, heat and CO_2), food production in the land available during the sugarcane field renewal,

reserve a fraction of total farm land for food production by the local population, make available irrigation water for the local farmers.

- How the advanced technologies can be implemented in the future to increase the competitiveness of the biofuel production: second generation biofuels, biorefinery concept, sugarcane especially bred for energy production, low impact mechanization.

What will be the desirable policy framework to support the biofuel program in the initial stages toward the self sustainability of the agricultural sector.

Simulation using computer modeling will be used to compare the possible alternatives in terms of the Project goals and the sustainability issues.

Expected Results and Contributions to the GSB Project

The main product of this activity will be a suggested bioethanol production model that will be, at the same time, adapted to the local conditions and evolving in the time with a target to become competitive in a near future, based on the three pillars of sustainability: economic, social and environmental.

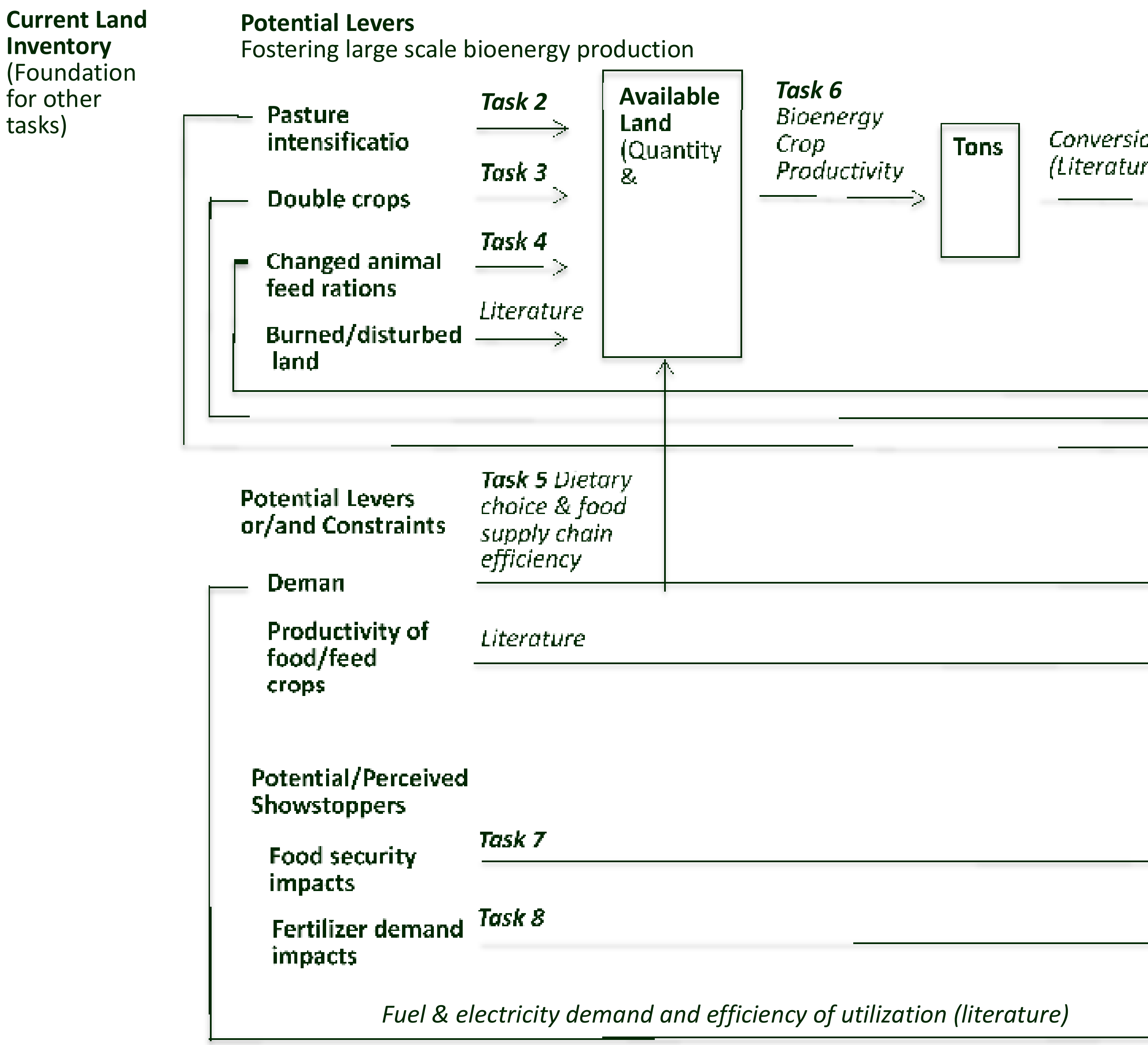
If the biofuel export potential exists than the requirements of the main biofuel legislation worldwide (Renewable Energy Directive and Renewable Fuel Standard) will be considered.

This activity will help the GSB Project by providing information on the social, economic and environmental impacts of the biofuel program in selected African countries, estimating the biofuel production costs and the desirable technology development and implementation.

5.4 Expected results from the LACAf-I project

The studies conducted in the LACAf-Cane-I project are going to be evaluated during the meetings carried out in Brazil, involving the project coordinators and main researchers, including the GSB members, and the regional meetings and visits carried on in selected case study countries (South Africa, Colombia, Mozambique and Guatemala).

The LACAF-Cane-I is an important part of the LACAf-Cane Program presented below at section 7 of the present proposal. The entire LACAf-Cane Program intends to be an important contribution to the GSB project tasks for the stage 2 presented below:



The programmed meetings are intended also to discuss the contributions to the GSB project, and will be used to redirect some specific objectives. A final meeting is programmed to occur in Brazil after which a final report will be presented.

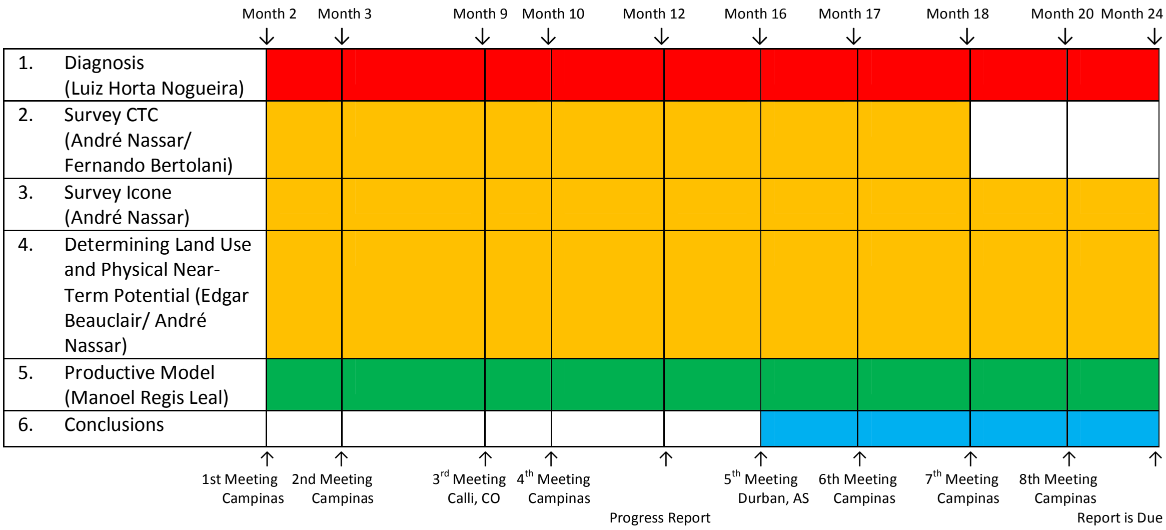
The results will be published in joint publications involving the GSB project coordination.

6. Meetings and Missions

6.a Meetings

A series of meetings are planned to occur during the project, according to the chronogram presented below.

LACAf-I Chronogram



Several long distance meetings are expected to occur along the project.

6.b Missions

The Meeting in Campinas, Brazil will be followed by visits to Piracicaba and Ribeirão Preto.

The South African Meeting will be followed by visits to Mozambique, Zambia, and Reunion.

The Colombia Meeting will be followed by a visit to Guatemala (CENGICAÑA).

The South Africa Meeting will be followed by a visit to Mozambique.

7. The LACAf-Cane Program, LACAf-Cane-I, Sub-Projects and Teams

The LACAf-Cane-I Project is intended to be the first of the proposed LACAf-Cane Program presented below:

LACAf Program/Bioen/FAPESP (October 18th, 2012)

Project	**“LACAf”-I** **Near-Term Potential Production of Bioenergy LA and Af**			“LACAf”-II Food Security	“LACAf”-III Fertilizer			“LACAf”-IV Socio-Economics		“LACAf-V” Environment Impacts	
Pesquisador Responsável (PR)	**Cortez**			**Jeremy**	**Cantarella**			**André Furtado**		**Suani Coelho**	
Sub-Project	Diagnosis Energy and Food Situation and Integrated Analysis	Determining Land Use and Physical Near-Term Potential	Production Models and Innovation	Biofuels and food security, complementarities, linkages modern-traditional agriculture….	Future Inorganic Fertilizer demand and Recycling Nutrients for biofuels	Effect of Sugarcane Trash and other residues in soil fertility	Precision Agriculture, No-Till and Soil Conditioning	Bioenergy and Food Scenarios in LA and Af	Social Impacts and Economic Development	Water use in Ethanol Production (Agriculture & Industry)	Water Quality and Atmospheric Emissions in Ethanol Production
Pesquisadores Principais (PP)	**Horta**	**Edgar Beauclair**	**Regis**	**Jeremy, Frank**	**Raffaella**	**Cantarella**	**Braunbeck**	**André Furtado**	**Márcia Azanha**	**Jansle Rocha**	**Osvaldo Lucon**
Pesquisadores Associados (PA)	Rincon, Emile, Espinosa, Lee L., Poppe, Kafarov, Jean Claude, Annie, Francis Y, Laurent, Frank, José Maria, Leonard, Manduca, Mauro	CTC, ICONE, ORNL, Nassar, Fábio, Cantarella, Alexandre, SASRI, CENICAÑA, Lamparelli	Bonomi, Jean Claude, Francis Y, UNISOMA, Emile, Rincon, Horta, Geraldo Martha, Beauclair, Leonard, Marco Tulio	Alexandre, Cantarella, Beauclair, Márcia, Annie, Emile, Horta, Regis, Geraldo Martha, Suani, Jansle, Marco Túlio	Cantarella Beauclair, Fábio, Robert Boodey	Raffaella, Beauclair, Fábio, ORNL, Regis, Galdos, Braunbeck	Cantarella, Raffaella, Graziano, Bonomi, Edgar Beauclair, Fábio, Zigomar	Márcia, Jeremy, Frank, Horta, Regis, Alexandre	Annie, Jeremy, Frank, André Furtado, Horta, Regis, Geraldo Martha, José Maria	Teixeira, Paulo Graziano Suani, Lucon, Folegati, ORNL, Jannuzzi, Silvia Nebra, ICONE	Suani, Moreira, Goldemberg, ORNL, Joaquim
Apoio Técnico e Administrativo (ATA)	Lilian (NIPE), Mauro (NIPE)			Lilian (NIPE)	APTA			Lilian (NIPE)		CENBIO	

APTA/Brazil (Heitor Cantarella, Raffaella Rossetto);
CEEEZ/Zambia (Francis Yamba);
CGEE (Marcelo Poppe);
CTBE/Brazil (Antonio Bonomi, Galdos, Joaquim Seabra, Oscar Braunbeck, M. Regis Leal);
CTC/Brazil (Antonio Celso Joaquim, Fernando César Bertolani, Felipe Haenel Gomes, Jorge Donzelli);
Dartmouth University/USA (Lee Lynd);
Embrapa /Brazil (Fábio Marin, Geraldo Martha, Robert Boodey);
ERcane/Reunion I. (Laurent Corcodel);
Esalq/USP/Brazil (Edgar Beauclair, Márcia Azanha);
IC, UK (Alexandre Strapasson, Frank Rosillo-Calle, Jeremy Woods);
ICONE/Brazil (André Nassar, Marcelo Moreira, Laura Harfuch, Gabriel Granço);
ISSCT/Mauritius (Jean Claude Autrey);
SU/South Africa (Annie Chimpahango, Emile van Zyl);
SMA/Brazil (Osvaldo Lucon);
ORNL, USA (Keith Kline, Maggie Davis, Virginia Dale);
UIS/Colombia (Vyacheslav Kafarov);
UNC/Colombia (José Maria Rincón Martinez);
UNICAMP/Brazil (André Furtado; Gilberto Jannuzzi, Jansle Rocha, José Maria Silveira, Leonard Sebio, Luís Cortez, Marco Túlio, Paulo Graziano Magalhães, Silvia Nebra, Paulo Manduca, Mauro Berni, Rubens Lamparelli);
UNIFEI/Brazil (Luiz Horta Nogueira);
UNISOMA/Brazil (Miguel Taube);
USP (José Goldemberg, Roberto Moreira, Suani Coelho);
Rodolfo Espinosa (CENGICAÑA/Guatemala);
SASRI;
CENICAÑA.

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