

Bioenergy and Food Security: Markets, Institutions and Regulation

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Summary

The discussion about bioenergy solutions and respective interaction with food security concerns continues to be a difficult subject in the international arena. The academic efforts to address the issue should be based on facts and models that allow a sound decision process. However, beyond theoretical considerations and model implications, the facts based on case studies provide, probably, the most powerful arguments, mainly when they are supported by some rationalization and a chosen reference model. The research we want to discuss is based on the study of the two major countries and “players” in the bioenergy initiatives and related agricultural changes driven by that process, USA and Brazil. The key factors to study the subject are markets, institutions and regulation needs, within a systematic approach, beginning with sustainability considerations (environment impacts), market behaviour and food prices and opportunities “versus” risks at local and global levels. For agribusiness opportunities it seems evident that bioenergy alternative is a powerful area for intervention mainly in less developed countries with available land resources. On the other hand, markets and mainly food markets need to be under consideration which might require institutional innovation and different forms of regulation, both public and private regulation.

More regulation does not mean, necessarily, less markets and more state intervention. In some cases it can be a decisive factor for better markets and more market economic driven changes. The actual research also provides examples of private regulation with good results.

1 Introduction and Problem Statement

Energy supply based on renewable natural resources and agriculture production, can be the base of new agribusiness activities, either at family level or based on large agribusiness firms. The big question has always been which impacts these new demands will have, mainly raising prices and reducing food supply and food security in the short run perspective but also in the long run horizon. It should be stressed that, nowadays, sustainability and climate change issues are the key aspects for long run analysis.

Agri-business and food systems have been under pressure, mainly after 2007 and food prices achieving the maximum around mid 2008, with those prices growing (commodities in general) with markets quite closely linked to the oil prices (US\$ per barrel). Simultaneously biofuels were accused of being responsible for, at least, part of the problem.

Proposition: Markets are not neutral to expectations in general overall economic behavior; they are not perfect and can be unstable mainly when reliant on few export producers and big economy of scale operations. Food production and technological innovation provided at world level are dependent on basic structural changes where, after the mid 80’s, for the first time in human history, the global food balance equation appeared with systemic food surplus. New demands and opportunities for Agricultural Production is a wonderful alternative to create value and development mainly for those countries with good natural resource base (land and water) like the **LDC’s in Africa and Latin America.**

Corollary 1: Biofuel production has been traditionally based on risk aversion and strategic behavior, since the 80's (Brazil mainly, but also recently for USA), but now represents a real opportunity to create value from agricultural sources without significant impact on food supply.

Corollary 2: Good institutions and regulation capability are powerful instruments to avoid potential negative effects, and should be based on public and private interests, with Governmental intervention but also with "civil society" initiatives.

2 Objectives

This article will provide sound data and analysis, showing how important biofuels can be to create value in countries with available natural resource base (land for agricultural production), how it can play an important role in growth and economic development opportunities in most countries with comparative advantages in those areas, but also how they have to assume some responsibilities to avoid negative impacts on food security matters. Simultaneously, it is expected that technological changes will have to be able to promote sustainable production systems and development¹.

For more developed countries, such as the EU countries and USA, challenges are more obvious in terms of required adjustments, production intensification, but also an opportunity to solve the structural surplus of food and agricultural production.

For less developed countries, mainly in Africa and Latin America, with natural resource availability to support agricultural business growth, a special role of agricultural activities for development is now possible, based on those new demands. Regulation and regulatory intervention needs, to support good market behavior, can be provided from several institutional initiatives (governments, associations, public and private institutions and respective partnerships including academic work, etc). Those contributions for good market functioning represent an enormous opportunity to be explored to add value and to promote value creation in a sustainable way linked to land and natural resources services. It is important to state that "good market behaviour" means that market is providing a Pareto Optimal solution (and not a "Sub-optimal allocation of resources in Pareto sense") and also showing a "normal behavior" in terms of stability, predictable conditions and delivering solutions within choices (auto-regulation) that reflects equilibrium among players (no one acting with power to influence results directly and with general good information throughout the system).

3 Main Questions and Hypothesis

There are opportunities, given a set of correct policies, to take advantages of the new "space" to create value within the food and agribusiness sector without significant impact in food security matters, if technological and institutional changes will occur fast enough.

The main contribution of the study is to provide evidence on the production growth potential and which factors can help worldwide production systems to answer to the new requests for

1. Sustainability concerns in the sense of WCED (World Commission on Environment and Development) report definition, presented at the General Assembly of the United nations, 1987, 11 December: Definition of sustainable development – "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

energy purposes without negative impact on food security and with changes that also take into account sustainable development concerns.

Active entrepreneurship in general and at the local level (family based initiatives) is one of the important promises to have the food and agribusiness sector in conditions to answer quite well to the new requests if demand constraints do not create limits to the accumulation process and technological changes (private initiative is the main driver for production expansion).

Government intervention (but also other actors) to help markets auto-regulatory (self-regulatory) capacity is a crucial issue requiring institutional innovation.

Government and Public Institutions have been playing a crucial role to define policies and to promote biofuels use and production, based on strategic and risk aversion rational (to lower the oil dependence) and also in terms of sustainability and environmental concerns (climate change). However new institutions are emerging providing new forms of governance of the food and agricultural systems, and examples of new regulatory intervention from private stakeholders providing support to better markets, a new window of hope in economic development for many countries.

4 Methods and Procedures

The theoretical background used for analysis is the Economic Development theoretical framework and respective models, using well known disciplinary referential materials, but also assuming an approach closely related with the World Bank practice and perspective carrying out its mission around the world. That is we start with the “revealed Market observed outcomes,” which means Markets are not perfect and can be improved with different technical skills (government and non government interventions, and certainly better if science based).

To be “transparent” and provide a systemic structural analysis, it is important to specify concepts used and the respective economic models referential that can help understand the observed changes. The Structural and Induced Innovation Models is used as the main reference.

Actual facts are listed to support the arguments, with quantitative data when possible but also looking at normative and public choices made in the two referential countries study, Brazil and USA.

4.1 Concepts and Main Assumptions

Food markets and oil markets (petroleum) have been connected. Primary commodities are, most of the time, connected in terms of the economic rational for prices vulnerability, but food higher prices always create an immediate problem for food importers (and food security concerns for less developed economies which depend on those products to solve their basic needs).

Markets are not perfect most of the time, especially in food and energy sectors, because there are several constraints, such as geographic distribution (production and consumption), economies of scale/dimension, asymmetries of information, etc.

Risk aversion and strategic behavior (speculation and other forms of risk games and risk aversion behavior) are frequently present both in energy matters and on food security grounds. However Risk Aversion behavior and respective countermeasures within a strategic view imply the willingness to pay a price to lower perceived risks. Many countries in political terms, taking into account the need to create alternatives to fossil fuels and taking into account environmental concerns have established plans and ambitious targets for biofuels. Those initiatives are likely to promote new markets for biofuels and new dynamic systems based on agricultural production capabilities closely linked to food and also to food security concerns.

Institutional innovation has been seen as important as technical changes in economic development models (Hayami & Ruttan, 1985, and others).

Institutions definition: institutions are the rules of a society or of organizations that facilitate coordination among people by helping them form expectations which each person can reasonably hold in dealing with others (Hayami & Ruttan, 1985);

The Market is frequently seen as an “institution” but also frequently as a natural (biological) phenomena; Today there is no doubt that markets perform differently according to the institutional “environment” and that both are important to understand the economic change processes. An “Ideal World” will achieve for tangible and tradable goods (with a set of “normal” most frequent characteristics, that is with “n” buyers” and “m” sellers, “n and m” big enough with no one with dominance or power to influence interactions, divisibility/ separability, perfect information, etc, etc), an equilibrium solution (market equilibrium) that satisfies some basic Welfare conditions. However the necessary conditions to guarantee “good market” performance are, most of the time, absent, and it is possible to identify, search and act accordingly with a lot of measures that can be taken to help building a “better market.” Those measures are not only responsibility of the Government, but a lot of stakeholders/actors on the system can also play a decisive role.

It is now important to introduce the perspective followed and respective view and proposals about “Regulation.”

- Proposition: Regulation is defined as the institutional framework that allows markets to perform well and/or to deliver Pareto Optimal solutions (when markets exist or can be designed to perform well).
- Corollary 1: Regulation is perceived as rules, norms and behavioral conditions that define economic actor’s role and help them to understand each other in the market place. Other necessary forms of regulation outside market referential will not be under consideration.
- Corollary 2: Forms of regulation are all types of measures that can be undertaken for government and/or for the society (civil society) to improve market functioning, and respective production and consumption systems.
- Corollary 3: Regulamentation is a component of regulation, most of the time a necessary condition but not a sufficient condition
- Corollary 4: Governments have a strong responsibility to provide the necessary legal and normative framework, but regulation is a responsibility of many actors in the economic system, starting with citizenship, individual and collective actions, where science needs to play its role.

The discussion about regulation and de-regulation is normally based on a dual view, liberal economic systems with markets solving “everything” versus a public intervention view (and state based economy), where “regulation” means State intervention.

The set of definitions (assumptions and derived concepts) support and help to specify in more detail the objective of the study and respective main hypothesis, where “regulation” is defined and seen in a complete different way. That is, regulation is a “necessary condition” for well functioning markets, most of the time, but regulation does not mean necessarily more Government intervention (some times the reverse), but also means stakeholders/other actors actions, where science and research can provide a huge contribution.

In other words, the correct institutional framework is a necessary condition for good market performance, which implies needs for action from government but also from many other actors/stakeholders in the system, where science, research and derived policy and proposals can make a huge difference improving Markets.

4.2 Main Referential Models

Growth models and structural models can help to provide solid background to understand changes rational, but our referential model is the induced innovation model from Hayami and Ruttan (1985) and the ICI model, Induced Changes and Innovation Model from Carvalho (2004, 2006) and also the author, PhD thesis (Minnesota University, 1989), Demand Constraints and Technical Changes. The main idea and rational is based on the great potential for production growth in agricultural systems (mainly in the tropics), with the nowadays knowledge and potential technology availability, which is restricted by the economic system (mainly demand and institutional factors).

Demand Constraints are the crucial problem to be faced in economic growth terms, mainly in agricultural systems. New demands, based on energy and environmental requests from agricultural production can be an opportunity, ever before present, to help solving growth and development constraints.

Localization Models are part of the historical theoretic background that also helps understand the basis of the arguments and tests used. Theodore W. Schultz (1953), Nobel Prize in Economics, for his work in Economic Development, dedicated to less developed countries and agricultural sector, also explored the economic rational to explain economic development differences among regions in the USA. He proposed a model, a localization model, where the rational was the difference among “markets efficiency,” “factor and products” markets. That is, markets perform better in the center, and are less efficient (poorer performance) in the most peripheral areas. Again industrialized-urban regions observed dynamics generate the formulation of the urban-industrial impact hypothesis with a series of studies to test both hypotheses, according to Hayami-Ruttan (1985): a) the empirical generalizations; b) the factor and product market rationale. Those studies sustained in general the validity of Schultz’s generalizations.

In the Induced Innovation Model, the author proposed a different version, where the endogenous rational for changes was explored, basically demand driven, but also stressing the importance of the Market and Government roles (Carvalho, 2008 at IAMA 2008 meeting, best paper candidate). Changes in agricultural production and growth with innovation, either technological or institutional, depend greatly on endogenous factors that can be identified,

where demand and supply interactions can be studied. Those interactions are dependent on economical structural changes that are inevitable for countries across the development process.

At this point it is important to review the “structural development model” proposed by Mellor and Johnston (1984), which presents those interactions defined in terms of “The World Food Equation.” In a very simple way, it is possible to explain the 3 different stages where any country/region can be placed in terms of the Food Equation Equilibrium, derived from the relationship between supply and demand for food. It is considered the following stages:

- . Stage/Phase I – Ecological Equilibrium
- . Stage/Phase II – Excess Food Demand (demand growth tends to be higher than production growth)
- . Stage /Phase III – Excess Supply (supply growth higher than the demand growth).

Most countries, considered less developed countries, are in the second phase, while most industrialized countries tend to be in the third phase. International Markets play a key role to help solving those disequilibria, but helping to loosen demand constraints is another key aspect that is frequently forgotten, where international markets are very important.

Demand Constraint hypothesis and derived model was presented in 1988 at the University of Minnesota, (Carvalho, 1989). It is proposed under a “General Development Model,” induced technological and institutional changes, stressing the importance of the Demand Driven factors on the induced change process. Linking both models rationale, it is evident that for Industrialized Economies (Phase III), like USA and most European countries that food surplus has been a permanent problem since mid 1980, and consumption growth very limited. Demand constraint is obvious, and more frequently a structural problem. For most LDC’s we might think that the dominant problem is how to promote supply growth, where demand problems are not relevant. Indeed, we tend to agree that supply growth is a huge problem, however development and growth will not be sustainable if demand constraints are not “solved” and/or relaxed within a long run perspective and correct development policies.

At this point it is important to be explicit and very precise on the necessary concepts and definitions, not yet presented. Demand Constraints is a terminology not frequently used, however, Supply Constraints is common, mainly in agricultural economics. It might be of interest to think about those differences and what can justify this fact , but here we want to point out the references we are using, presenting the following definitions (absolute demand constraints and relative demand constraints):

- Demand Constraints in absolute terms are defined as the physical needs that can be necessary to fulfill human desire for consumption in a sustainable and healthy environment; It is defined in terms of the Frontier of the possibilities for consumption;
- Demand Constraints, in relative terms, are defined as the set of factors that can avoid social effective demand to reach the consumption level related to the existing potential demand (preferences), given the availability of resources, technology and knowledge for a given society in a sustainable development process.

With these definitions it is transparent how demand constraints are important for industrialized economies, and how they can be very important for less developed economies.

It is neither the time nor the place to go into more detail on those aspects, but it might be helpful to point out more direct and indirect measures that can serve to evaluate how demand constraints can have impact on the economic system, particularly on the food system dynamics. Examples of those indicators are the following:

- Demand Income Elasticities
- Demand Price Elasticities
- Consumption Alternative Forms (needs type – basic needs, leisure, luxury, etc.)
- World Price Variations – price volatility.
- Time Frame for Consumption (output durability)
- Transformation Alternatives and Different Utilizations.
- Markets Integration – regional and international links and trade.
- Information and Inter-Markets Connections
- Support Infrastructures - like transport systems availability, information, etc
- Value creation along the chain and respective value distribution (presence of market power and asymmetric relationships).

Within this framework it is possible to understand how important the demand constraints are either for industrialized economies or less developed countries in food production and agricultural development. The evidence showed in the last decades that enough food supply does not mean food security globally, at the same time showing that from a Malthusian perspective in mid 70's, with the oil and commodity price crises in 1973/74, with general failure in supply, the world jumped to a global food surplus since the mid 80's. The last international volatility of prices in 2007/2008, achieving the higher food prices generally in mid 2008, didn't change the structural tendency for surplus in industrialized countries, besides the huge utilization of corn for ethanol production in the USA. The graphs below supported the comments above, showing that the highest level of cereal per capita availability in the world did not changed the hunger problem in the world, which is basically a development problem and poverty alleviation needs.

Most food security problems are basically local and not global after mid 1980's, and linked with problems related with access to food and income constraints (demand constraints). Potential demand is there, but access to food is the real problem, based on failures to local food availability and income constraints. At the same time in many situations there is no production because there is no market (or effective demand), and in many tropical regions the "paradox" is even more evident with available resources, technology but no economic space for effective production activity with conditions to provide "economic surplus" and accumulation process, which means there is no conditions for sustainable development and business dynamics in the food system.

World per capita cereal production

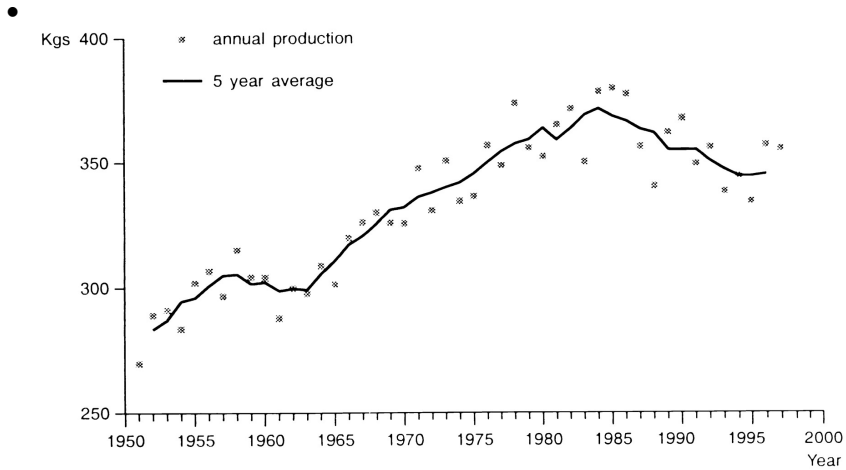


Figure 1.

Source: Dyson, T. (1998). The National Academy of Sciences

World Cereals: Prices, Stocks and Donations, 1960-1997

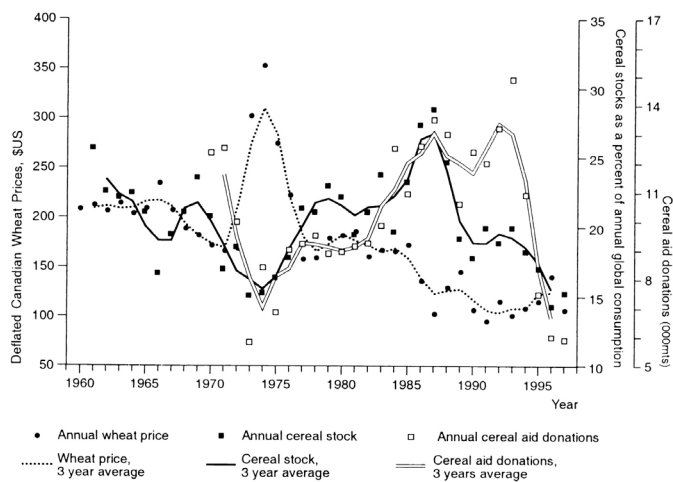


Figure 2.

Source: Dyson, T. (1998). The National Academy of Sciences

Those numbers and data are quite transparent to put in evidence that supply growth continues to be a challenge, but mainly at local level and as a mean to raise incomes of the poor and rural people. The FAO 2009 work (clearly at the International November meeting)

calling attention on the needs to continue the efforts in agricultural production growth are welcome at world level, but also at local specific level. However the most problematic situations need to be addressed at local level, and demand constraints solved or relaxed, which means, most of the time, the need to start with measures to raise incomes of the rural people.

The recent historical behavior of the food system at World level, last quarter of the twentieth century showed, in a very factual way, that supply growth still is a problem but probably not the most import one in the next future if we want to achieve the United Nations millennium goals. Looking at the Population dynamics of the last century, and comparing it with the past and the prospects for the next future it is worthwhile to note that the 20th century was the period in human history with the biggest growth ever in absolute terms. In relative terms and (in gross terms) the population increased by a factor of 4, that is from around 1.5 billions persons (more precisely from 1.65 billions on the entrance of the 20th century) to 6 billions.

The pressure form the demand side was the biggest in the last quarter of the century, exactly the one where the world achieved a permanent tendency for surplus overall (with great contribution on the supply side overall and also a result from industrialized countries agricultural growth with little growth in population).

The actual century prospects for population growth slowed down significantly the previous trend. Note that from the first billion people, estimated to be achieved in the beginning of the 19th century, the second billion was achieved around 1930. It took around 130 years to increase 1 billion people around the world. At the end of the 20th century a 1 billion person increase in the population was achieved in 11 years. The prospects for the actual century are of slowing growth rates. Around 2025, 8 billion people are expected and 9,4 billion in 2050. The population is expected to reach (at the maximum) around 12 billions at the end of the century, and hopefully to stabilize between 12 and 15 billion. However, estimates are uncertain, but a clear stabilization process is foreseen with reduction in growth rates from now on, which means lower demand pressure growth than reached at the end of the 20th Century (and beginning of the 21st Century), when a structural supply surplus was achieved. Technology, engineering and agricultural production activities achieved tremendous growth (and success) in the second half of the century, ant the Malthusian view still present in the 1973/74 food crisis (commodity and oil crisis) were not a relevant issue at the end of the century.

Year	Population	Year	Population
1	200	1975	4000
1000	275	1990	5300
1500	450	1999	6000
1804	1000	2011	7000
1927	2000	2025	8000
1960	3000	2050	9400

Figure 3. Population Data References (estimations – millions)

Source: M. Rosenberg (2009) in www.geography.about.com

The conclusion derived above does not mean there isn't a huge challenge ahead in terms of sustainability concerns, and also in terms of Food Security, locally and globally. It is however stressed, that supply growth problems have been solved up to now, but access to food, mainly distribution, poverty alleviation and local development have not been achieved. Food problems will continue a priority in development terms and global citizenship, but not only in terms of access to food but also in terms of quality of life, mainly in food habits, consumption behaviour and food quality. Today, according to European Commission (2009), at World level 1.2 billions persons are estimated to be obese and 860 millions malnourished. The profile of needs in terms of food will also change with the demographic changes. Today in Europe 1/5 of the population is already above 65 years old, and it is estimated by the same source to be around 1/3 in 2025-2030. Structural changes are under way, and food demand growth will not be bigger than the one already achieved globally.

The structural conclusions derived from economic development modelization, provided the background to look at the food supply impact of the new demands, mainly from bioenergy sources, globally but also in terms of the two most important countries entering into production of biomass for bioenergy purposes, Brazil and the USA.

Before finishing the theoretical background to test our main hypothesis and arguments, the last important concern we want to address is the impact of the new demands for agricultural production with the new bioenergy initiatives and respective price behavior. The problematic issue of higher food prices is discussed based on historical data and recent markets behaviour. Theoretic arguments about the impact on food supply and food access will be rooted and mostly based on empirical and historical behaviour. "Arguments and models" against facts are always difficult to be accepted for policy design and sustainable analysis. Higher volatility in food markets have been a strong problem worldwide, after 2007 and during 2008. The linkage with the bioenergy initiatives has been frequently done. As it is well known bioenergy production initiatives worldwide with significant dimension have been made by Brazil, after 1975, and by the USA in the actual decade. For Brazil the equation is based on sugar-cane production and its impact on food supply. For the USA the issue is centered in corn production and basically on the impact towards corn markets of this new demand.

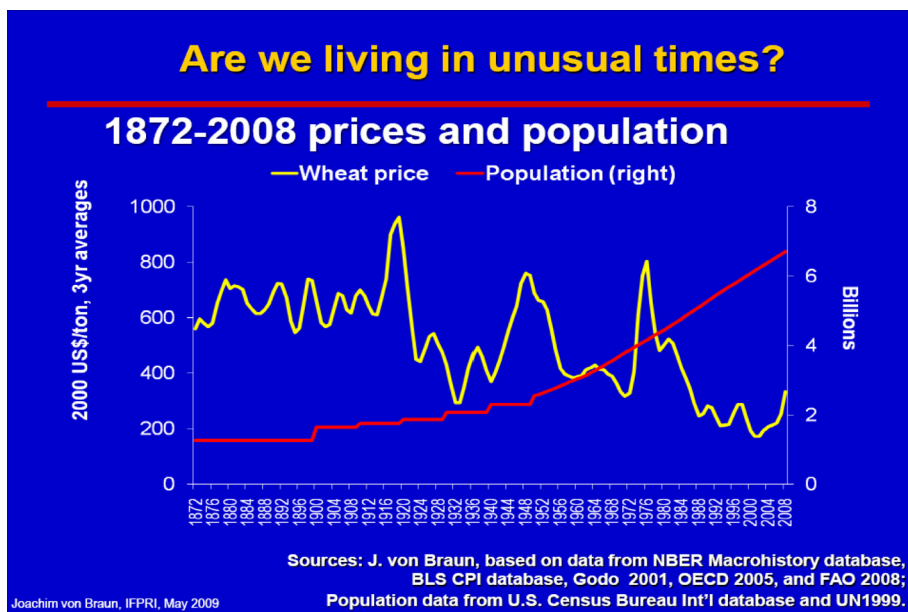


Figure 4. Trends for Prices and Population since 1872

Source: Von Braun, J. in Hans Johr at IAMA Forum (2009) - invited presentation

Again we need to understand that agricultural innovations have been tremendous in last half of the twentieth century. Prices at the market place reflect the interaction between supply and demand dynamics, both dependent of a very large number of different factors.

At this point we are in conditions to derive some theoretical conclusions, pointing out that Demand Constraints should be studied in several different perspectives, and also stressing that Bioenergy and Environmental demands from agriculture can be a tremendous opportunity (solving demand constraints) for the agriculture sector, food system dynamics, and global sustainable development, mainly toward countries with natural resources availability, such as the USA, and most countries in Latin America and Africa. At the same time to have an effective sustainable development process the role of innovation, either technological, but mainly institutional requires a new perspective for the role and needs of "Regulation," ("institutional innovation" - defined as an objective for better markets with partnership between governments and other economics actors, with less and less government intervention when possible) with better governance of the food systems and better markets.

4.3 Bioenergy and Food Security: global perspective and the study of the USA and Brazil examples

The main facts can be described as follows:

- 1 - Output prices at farm gate have been very unstable with markets volatility mainly in 2007 and 2008, but are now in real terms for maize at the level of the beginning of the decade of 1980;
- 2 – Biofuels have been growing globally, tripling between 2000 and 2007, and continue to grow, but still represents less than 3% of the global transportation fuel supply (Amber Waves 2007).
- 3 – Biofuels are now part of a solution portfolio for high energy prices, but can be significant in some countries as transportation fuel. Nowadays they are dominant only in one country for private cars, Brazil.
- 4 - However the production is now concentrated (90% of all biofuels are based on USA, Brazil and EU) – According to Amber and Waves (2007), US represents 43%, Brazil 32% and the European Union 15%. Others have no significance, with China 3% and other North & Central America with 2%, Thailand, India around 1%, and Oceania and the rest 1% or below.
- 5 - Worldwide, countries with resources and comparative good conditions in agriculture production will face enormous opportunities, but at the same time food security concerns will be maintained, mainly in less developed countries.
- 6 – Using as reference 2007 production forecast (million gals) based on ERS/USDA and Amber Waves 2007 publication (with data already outdated, but still comparable for several countries goals and structure of production) provided a global overview given below.

Country	Source Ethanol	– Source Biodiesel	– 2007 Prod. Ethanol For. (million gals)	2007 Prod. Biodiese 1 (million gals)	Blending Targets
Brazil	sugarcane, soybeans, palm oil	castor seed	4,966.5	64.1	25 percent blending ratio of ethanol with gasoline (E25) in 2007; 2 percent blend of biodiesel with diesel (B2) in early 2008, 5 percent by 2013.
Canada	corn, wheat, straw	animal fat, vegetable oils	264.2	25.4	5 percent ethanol content in gasoline by 2010; 2 percent biodiesel in diesel by 2012.
China	corn, wheat, cassava, sweet sorghum	used and imported vegetable oils, jatropha	422.7	29.9	Five provinces use 10 percent ethanol blend with gasoline; five more provinces targeted for expanded use.
EU	wheat, other grains, sugar beets, wine, alcohol	rapeseed, sunflower, soybeans	608.4	1,731.9	5.75 percent biofuel share of transportation fuel by 2010, 10 percent by 2020.
India	molasses, sugarcane	jatropha, imported palm oil	105.7	12.0	10 percent blending of ethanol in gasoline by late 2008, 5 percent biodiesel blend by 2012.
Indonesia	sugarcane, cassava	palm oil, jatropha	--	107.7	10 percent biofuel by 2010.
Malaysia	none	palm oil	--	86.8	5 percent biodiesel blend used in public vehicles; government plans to mandate B5 in diesel-consuming vehicles and in industry in the near future.
Thailand	molasses, cassava, sugarcane	palm oil, used vegetable oil	79.3	68.8	Plans call for E10 consumption to double by 2011 through use of price incentives; palm oil production will be increased to replace 10 percent of total diesel demand by 2012.
United States	primarily corn	soybeans, oilseeds, animal fats, recycled fats and oil	6,498.7	444.5	Use of 7.5 billion gallons of biofuels by 2012; proposals to raise renewable fuel standard to 36 billion gallons (mostly from corn and cellulose) by 2022.

Figure 5. Biofuel blending targets – selected countries

Source: ERS/USDA, November 2007

7 – The information on ethanol markets

7.1 - Production for 2008 is given below and shows that within biofuels, ethanol is completely dominant. Biodiesel only has relatively high importance in Europe.

__ Global Production of Ethanol – 2008

Country	Liters (Millions)	Percent
USA	34 065	51.92%
Brazil	24 497	37.34%
European Union	2 777	4.23%
China	1 900	2.90%
Canada	900	1.37%
Other	486	0.74%
Thailand	340	0.52%
Colombia	300	0.46%
India	250	0.38%
Australia	100	0.15%
TOTAL	65 614	100.00%

Figure 6. Ethanol production

Source: Reis,2008 and Única, 2008 in Carvalheira (2009).

7.2- Demand forecast can be estimated under several scenarios, according to Rodrigues (2008) in Carvalheira (2009):

Scenario 1 – 5% gasoline substitution -----48,8 Billions of liters
 Scenario II – 10 % gasoline substitution -----97,6 Billions of liters
 Scenario III – 20% gasoline substitution -----195,3 Billions of liters

7.3- Country Targets for Ethanol/biofuels substitution

It is important to note that there is a global move toward the use of biofuels, but it is a recent move for most countries. The production is still concentrated in few countries, and dominated by ethanol, with the only exception being Europe, where biodiesel dominates (in 2007 estimates for EU were 1731,9 million gal. of Biodiesel and 608.4 million gal for Ethanol (ERS/USDA- Amber Waves 2007).

EU goals according to the Directive 2009/28 – April sets a mandatory target of 20% share of energy from renewable sources in overall Community energy consumption by 2020, and a mandatory 10% minimum target for the share of biofuels in transport petrol and diesel consumption by 2020.

USA goals are set on ethanol production levels of 15 billion gallons for 2015. There is still a limit of 10% substitution of Gasoline, which is now under possible revision decision (corresponding 13 billion gallons to 8.25% of the national sales today – 2010 consumption estimate) and 36 billion gallons for 2022.

<i>Established</i>	<i>%</i>	<i>Planned</i>	<i>%</i>
Brazil	23-25	Canada	6
India	5	Mexico	10
Thailand	10	Costa Rica	5
Filipinas	5	Bolivia	25
Taiwan	5	Argentina	5
China	10	United Kingdom	5
Sweden	5	France	7
Colombia	10	Uruguay	10
Japan	3	Australia	10

Figure 7. Ethanol Targets Worldwide for Several Countries

Source: F.O. Licht's World Ethanol Conference 2008 In: Scott, W. IAMA 2009

8.- The USA growth on Ethanol production has been very high, and became the first World producer recently after 2004-2005. The data available shows a tremendous leap after 2005. Brazil was the biggest ethanol world producer up to 2004/2005, had decreasing production during the last years of the 1990 decade, but growth began around 2000 and now after 2006 is growing also at a very fast rate (similar to USA).

9. -The last information about US behavior in terms of production can be summarized as follows:

9.1- The RFS – Renewable Fuel Standard (2005) mandate points out to 7.5 billion gallons for 2012;

9.2- Energy Bill (December 2007) doubled the RFS for ethanol to 15 billion gallons by 2015.

9.3- Conley (2008) points out the actual USA production of 8.6 billion gallons per year, in March 2008;

9.4- The new energy policies included a mandate that triple production of ethanol and other biofuels from 11 billion gallons last year (2009) to 36 billion in 2022. Jennifer A. Dlouhy (2010, in Chron.com/2010.02.04) mentioned that under that renewable fuel standard, which the Environmental Protection Agency (EPA) made final on Wednesday the 3rd of February 2009, biofuels must make up to 8,25 percent – or 13 billion gallons- of the nation's gasoline sales this year.

10. – The EPA has said it expects to decide this midyear whether it will hike the current 10% cap on the amount of ethanol that can be blended into gasoline. It is now possible to forecast that the "Blend Wall" (which limits ethanol to 10% of the gasoline pool) will be a constraint very soon. Gasoline with 10% ethanol can be used in any vehicle manufactured after 1980 in USA.

11.- The economic impact, according to a January 2008 study (Economic Impact of the Energy Independence and Security Act of 2007, LECG LLC in www.ethanolrfa.org/resource/standard), of a 36 billion gallon is as follows:

- a) Will add more than \$ 1.7 trillion to the Gross Domestic Product between 2008 and 2022;
- b) Generate and additional \$ 436 billion of household income for all Americans during the same period;
- c) Support the creation of as many as 1.1 million new jobs in all sector of the economy; and,
- d) Generate \$209 billion in new federal tax receipts.

12.- Brazil data also shows the big importance in economic terms of the sector, (sugar cane industry) which can be seen in the last two years in the table below:

Reference	2006/07 Production Year	2008/09 Production Year
Nº of Production Units	344 industries	420 industries
Relative weight on Ag. GDP	8%	6,52%
N. of Workers/Employment	4 Millions (Direct and Ind.)	4,5 Millions (Direct and Ind.)
N. of Farmers	72000	72000
Sugar Cane Processed	420 millions ton.	560 millions Ton.
Production – Sugar	30 million ton.	32 million ton.
Production – Ethanol	17.5 billion liters	27 Billion liters
Exports – Sugar	19 million ton. (US\$ 7 billions)	20 million ton. (US\$ 9 billions)
Exports - Ethanol	3 billions liters (US\$ 1.5 bi)	5 billion liters (US\$ 2.2 bi)
Tax – Gov. Income	12 billions Reais (R\$)	13 billion Reais (R\$)

Figure 8. Sugar-Cane Industrial Sector

Source: JornalCana, 2009 and MAPA in Carvalheira (2009)

13.- Corn Production have been growing in the USA, but the impact in international markets have been negligible in physical terms , since Exports of corn during the last years have not diminished, being rather stable or even growing. Production growth has been significant for local markets, but exports continue to grow after 2000, when bioethanol production begins to have some relevance. In relation to corn prices (average world export FOB prices in \$ US – nominal prices) it is important to recognize that prices fall in nominal terms up to 2000, but also in real terms up to 2006. The market vulnerability began in 2007, with prices at 197 \$US/ton (reference 11 December, 2007), increased a lot in 2008 (reaching by mid June 310 \$US/ton) but in mid December already at reasonable level, 173 \$US/Ton. Last mid December (2009) prices were at 181 \$US/ton. In conclusion, the prices have been reasonable stable in 2009, and not above the level of 1980 in real terms (Reference prices from USDA/IGC/FAO in ANSA – Agência de Segurança Alimentar de Cabo Verde).

	1970	1980	1990	2000	2006
World Harvested Area (Ha)	114 137 735	125 748 022	132 383 618	137 233 049	151 552 099
USA Harvested Area (Ha)	23 748 645	29 661 035	27 053 933	28 557 000	31 333 613
World Production (T)	282 981 612	420 669 633	484 866 675	605 160 599	736 112 417
USA Production (T)	122 649 237	192 084 005	194 239 168	244 259 997	293 662 273
World Exports (T)	29 437 301	78 376 442	71 879 046	81 646 822	98 509 650
USA Exports (T)	13 751 304	59 083 573	51 081 296	49 296 566	53 422 574
World Average FOB prices \$US/Ton		149.54	136.05	106.63	138.88

Figure 9. Basic Corn Data: World and USA harvest area, production and exports (three year averages, and average world FOB prices

Source: FAO, 2009

14 – In Brazil, the impact of the sugar cane sector in overall agro-sector can be evaluated with a simple chart presented below, showing expansion area of sugar cane and grains production. In summary, production growth of sugar cane and grain production are in similar growth patterns.

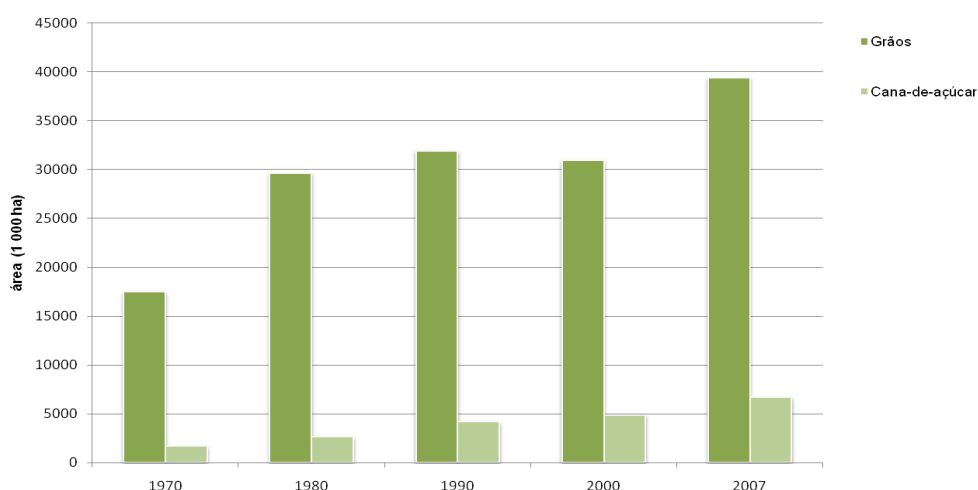


Figure 10. Crop Area Evolution for sugar cane and main grain crops (corn, soybeans, wheat and rice).

Source: USDA and FAOSTAT (2009) in Carvalheira (2009)

5 Discussion and main results – opportunities and challenges

Biofuels is a new area of interest for most countries, and a good example of policy intervention in creating an alternative for agricultural production, with great impact in economic value creation from agricultural activities.

Indeed, since the Ford experiences, biofuels have been always a possible alternative for liquid fuels, and since the Second World War used once in a while, mainly ethanol to substitute gasoline, but also some vegetable oils (including for lightening in public spaces, like the case of *Jatropha Curcas* oil from Cape Verde used in Lisbon city).

However, biofuels began to be an important issue with the petroleum markets becoming very aggressive, prices above \$US 60 /barrel and also because of the environmental impact and climate change issues

5.1 The Economics of Biofuels – basic background

We can say that there are experiences with ethanol as biofuel since the beginning of the twentieth Century (for example there are references of some experiences in Pernambuco in 1919), mainly after 1920, and with other biofuels, but the development of biofuels alternative was clearly created/induced through “policy intervention.” That is the markets alone did not provide enough incentives for private investment.

Since the beginning of the biofuels programs, there is a clear long run perspective, a risk aversion behavior and also a strategic planning view to promote the sector. More recently environmental concerns and climate changes are new motivations bringing those alternatives into equation.

PROALCOOL program created in 1975 in Brazil is probably the oldest significant Governmental intervention pushing the biofuels alternative worldwide. The big push for that initiative was the petroleum crisis of 1973/74 and the dependency from abroad on energy alternatives (adding to that the balance of payments problems).

Production cost has been always under consideration on every program, but risk aversion and strategic considerations were always important aspects to be taken into consideration.

Today, only Brazil can directly compete with the fossil fuel, where UE and USA still have, most of the time, higher production costs (regarding oil prices), which implies subsidies for private production. The USA subsidy according to Bachi and Barros 2008, (in Carvalheira 2009) is US\$ 134 / m³. This is not the case for Brazil, which according to FAO 2007, (cited also in Carvalheira 2009) has 46% of the European Costs and 71% of the USA costs. To that result it is very important to consider the technological evolution in the Sugar/Ethanol Chain in Brazil, at the level of agricultural production but also in terms of industrial evolution.

5.2 The Regulation of the Sector and the Brazilian Example

As already stated, Governmental programs and public policy and intervention has been a necessary condition for Biofuels production everywhere. Brazil example of many public interventions, trying to regulate markets began at the end of the 1920 decade, trying to protect the Industry in North-East region. In 1933-34 the IAA (Instituto do Açúcar e do Alcool) tried to control the surplus on sugar production and encourage Ethanol production. After 1943 minimum prices were established for sugar and ethanol (below export prices). In 1967 a new policy was established with prices based on regional production costs, method used up to 1999.

This short summary of the main interventions on markets finally began to change in the 1990 decade, with the initial liberalization move that ends with the complete market liberalization, however with regulation, but indeed a private regulation system. This new move, starting basically with governmental regulation, based mainly on rules and regulamentation, with prices controlled by government evolved to a liberal market regime, based on market auto-regulation capability, but also with private new institutional innovation

and intervention (new forms of regulation and governance), with prices established at market level. This evolution happened slowly during the 1990 decade, with the first reference law published in 1991, but with other legal instruments entering into action only in 1996/1997. Indeed the private S. Paulo industry was able to create a new “institution” CONSECANA

(Conselho dos Produtores de Cana de Açúcar e do Alcool de S. Paulo), established in 1999, which created a system of payments based on technical grounds

(basically using the ATR – Açúcar Total Recuperável, which is the content on sugar utilization capability). This new regime is now the reference for more than 95% of the processing industry payments and provides, with technical base, the value distribution (and payments) along the chain giving producers a mechanism to use markets without fear of distortions and abuses from market power distortions. New forms of governance are now in place, without public intervention, and new forms of regulation emerge helping markets to perform better.

6 Conclusions

1 – Biofuels continue to be an important growing industry in many countries, mainly in USA., Brazil and EU, but also in many other countries. Today production and consumption is concentrated in very few countries, but international markets are likely to grow in importance in the next future.

2 – The two major countries involved in biofuels at large scale do not show any negative impact on international markets, either in exports of corn or sugar/ethanol, the direct products involved, and do not seem to have other indirect significant impact in long term and trend analysis (including in price behavior tendencies).

3 – The development models show the surplus tendency for industrialized economies in food balance terms. For the less development world, with potential good growing conditions in agricultural terms we have to recognize the new opportunities for ag. business and family poverty alleviation. Demand constraints are still an important problem very much linked with poorly functioning markets in less the developed world.

4 – Food security problems were not solved with the highest food per capita supply.
– Population Growth in the 20th century was multiplied (in gross terms) by a factor of 4, that is 400% growth between 1900 and 2000. This is the biggest growth ever in human history in absolute terms.

(The 21st Century, if things move smoothly, it is expected a maximum of 100% growth);

5 – World per capita cereal production has been growing “since the beginning of the human history” (with data available since 1950), but reached its maximum around 1985.

6 – Food Security Concerns have been growing all over the world, but not for global lack of food.

7 – Indeed one of the most important “Paradoxes” of modern society is “how can we stand with close to one billion people lacking food access, when availability is not the problem.” Now we have also another problem of malnutrition with surplus consumption (with more than one billion obese people).

8 – Poverty alleviation and Consumption education and information are key factors if we want a healthy and more sustainable society. A systemic perspective is clearly necessary, linking production and consumption constraints with technological and institutional solutions (mainly with better markets and regulation)

9 – Food Problems continue far beyond global supply solutions. Demand constraints are now much more evident. New demands for energy are an opportunity.

10 – Regulation and Public Policy has been crucial for biofuels growth, but it is also an important fact to note the importance of the private intervention on regulation in many cases. The Sugar/Ethanol industry in Brazil is certainly an example to follow.

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