

## **Introduction**

Mankind is facing a paradigm shift as regards energy: turning from the use of fossil fuels, of non-renewable sources, to the generation of energy from renewable sources, in harmony with the environment.

This step raises serious questions as regards its impact on the generation of food. In this context, the case of Mexico is a special one for two reasons, the first being that its staple food is corn – one of the raw materials for the production of ethanol – and the other that it is an oil-producing country.

Does Mexico need to turn to alternative sources of energy? If so, does the Brazilian path or that of the U.S. constitute the model to be followed? Or would the shift, on the contrary, imply putting the food supply at risk?

In order to answer these questions the present paper firstly broaches the different forms of use of energy, then analyzes the oil situation in Mexico, that of agriculture as regards the production of corn and sugar, that of food consumption, and lastly the options open to the country.

## **Bioenergy – traditional and modern**

Bioenergy is perceived as a coin with two sides: it is the dominant source of traditional energy for more than a third of the world population, which generally employs it on a small scale, in an inefficient and therefore contaminating way<sup>2</sup>, and at the same time it is the modern renewable energy source exhibiting the fastest growth, with the capacity to produce fuels for transportation, power for industrial uses or large-scale energy services. Both sides, the traditional and the modern, represent large challenges for the achievement of sustainable development (Sagar and Kartha, 2007:2).

## **Traditional bioenergy**

One of the major challenges of traditional bioenergy is that its employment is rooted in day-to-day practices, such as food preparation and home heating and lighting, which are performed inside dwellings in an inefficient manner. In other words, practices that go hand in hand with poverty and which are, consequently, hard to eliminate. In a 2007 review of Sagar and Kartha, it is stated that the effects of depending on biomass as a traditional source of energy are currently seen with greater clarity:

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<sup>1</sup> Professors-researchers of the Sociology Department of the Metropolitan Autonomous University, Azcapotzalco.

<sup>2</sup> This refers to animal dung, agricultural waste and wood in diverse forms.

- The task of collecting it falls to women and children who devote 3-4 hours daily to this activity and have to travel several kilometers (between 5 and 10) for it. When children are involved in this activity their schooling is also affected.
- The use of biomass for energy services for cooking, lighting or heating the home is the main source of contamination of the latter – the array of contaminants is very broad<sup>3</sup>, with adverse effects on health<sup>4</sup>, especially for women and small children. The World Health Organization estimates that the contamination of the inside of dwellings because of the burning of biomass is the sixth-ranking risk factor facing health in the less developed countries, which implies major social and economic costs.
- Progress has been made as regards a better understanding that the burning of biomass, by coming from diverse sources, has fewer effects than were believed vis-à-vis large-scale deforestation – this being most applicable when referring to rural use. Nevertheless, the burning of biomass in stoves generates – because of the way it is carried out – combustion by-products that have significant implications for global warming.
- The poorest people generally devote a larger percentage of their income to fuel than those who have greater income; the fuels they most employ are traditional biomass, and as they rise on the income scale they gradually shift to more modern and less contaminating fuels.

The options that have been posed to reduce the negative effects of the traditional employment of biomass have centered on modifying stove designs, with variable results; other alternatives that have been promoted are the use of biomass in biodigestors and the substitution of the direct combustion of biomass by fossil fuels or by ethanol, etc.

In the view of Sagar and Kartha, the desirable approaches for counteracting the negative effects of the traditional uses of biomass would be those that complied with the largest number of the following aspects (2007:5-6):

- Reducing the levels of contamination and human exposure within the home
- Increasing the fuels' efficiency
- Reducing stress on the local environment
- Contributing positively to the family and working environment, particularly for women

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<sup>3</sup> Carbon monoxide, nitrogen oxides, aldehydes, benzene, other polycyclic aromatic hydrocarbons and contaminating particles, etc. (Sagar and Kartha, 2007:4).

<sup>4</sup> Acute respiratory illnesses, chronic obstructive pulmonary disease, evidences of lung cancer, tuberculosis, asthma and cataracts (Sagar and Kartha, 2007:4).

The supply of modern and non-contaminating energy services is clearly a priority in an agenda oriented at mitigating social inequality for people with low income in less developed countries, whether the former originate in fossil fuels, coal, biomass or other alternative sources; in any of those cases, abundant resources are required.

### **Modern bioenergy**

Various reasons exist for the rising interest, for a country such as Mexico, in fuels generated on a commercial scale on the basis of biomass:

- In the first place, the ever more widespread perception that the supply of oil as it exists is finite, and that the demand for liquid fuels for a sector of global transport has put the refining industry on the spot, the results of which have been increases and great volatility in the prices of oil. In fact, prices above 50 dollars per barrel have long been surpassed – the figure above which alternative sources of energy, such as those obtained on the basis of biomass, become attractive (Chauvet y González, 2008).
- In the second place, a considerable number of countries show concern for aspects of energy security, be it investing in domestic resources or diversifying international sources. In this regard, the availability of sources of biomass is distributed across the world in a less unequal way than oil and its eventual development and use on different scales ought to be a research priority for countries like Mexico.
- Thirdly, the issue of climate change also points to the desirability of reducing the emissions originated by fossil fuels, which has focused interest on large-scale bioenergy production
- In the fourth place, the opportunity for rural development that is offered by biofuels constitutes one of the reasons posing the largest number of challenges.

### **The effects of biofuels**

The effects of biofuels are multidimensional and could vary case by case, depending, among other things, on the biofuel considered, on the raw material employed and the infrastructure required for gathering it, on the scale and practices of production and/or utilization and consequently on the resources involved; the above may also vary by region, etc. In the following Table a classification of the possible effects of biofuels is presented:

List 1. Possible Effects of Modern Biofuels

<i>Area</i>	<i>Kind of effect</i>	<i>Example</i>
Food	Food security	<i>Increase in food prices, availability</i>

Environment <i>type</i>	Biodiversity	<i>Intensification of monocultivation, conversion of natural ecosystems into agricultural ones</i>
	Use of chemicals	<i>Modification of the distribution of species</i>
	Deforestation	<i>Increases in the use of chemicals that contaminate the air and water</i> <i>Effects on wildlife, soil erosion, increases in effects of gases of the greenhouse</i>
	Unexpected effects	<i>Not foreseen under this type of methodologies</i>
Health Toxicity and allergenicity	Contamination	<i>Reduction of effects associated with the use of fossil fuels</i>
		<i>Effects associated with the intensive use of agrochemicals</i>
Agricultural	Use of the soil	<i>Competition with foodstuffs, changes in the use of the soil</i>
	Stability in the supply of raw materials	<i>Sustainability, trend toward monocultivation and price imbalances</i>
	Agricultural practice	<i>Training for substitution of traditional practices, resources required for intensive cultivation, increases in prices of agricultural crops</i>
Energy	Energy security	<i>Increases in the supply of fuels, price stability, diversification of sources of supply</i>
Economic <i>competitiveness</i>	F/the consumer	<i>Prices at retail level</i>
	F/the producer	<i>Yield, added value, costs of inputs and of production, new products,</i>
	F/the processor	<i>Profit, product acceptance, competitiveness, generation of new economic activities, imports substitution, access to technology, exports</i>
	Employment	<i>Rural/urban, type of qualification, rate</i>
Social <i>migration processes</i>	Individuals	<i>Consumer choice, transparency, accessibility, participation, rural-urban</i>
	Institutions	<i>Concentration of power, institutional trust, regulatory complexity, certification</i>
	Social needs	<i>Opportunities, opportunity costs, social participation in giving direction to a technology, quality of life, need to generate agreements among social actors</i>
	Poverty	<i>Modification of indices (life expectancy, living standards, education)</i>
	Employment Inequality	<i>Child labor, employment for women</i> <i>In distribution of income, in opportunities</i>

The Table shows effects that are clearly positive for some actors and negative for others but, in the majority of cases, this isn't a zero-sum game – a very important consideration when the time comes to evaluate those effects. An aspect requiring to be taken very seriously into account is that many of the different kinds of impact are qualitative in nature. Additionally, the relative priority associated with the different dimensions of the effects is strictly a matter of value judgments with a high degree of subjectivity.

Some of these possible effects have triggered great interest in society and have generate controversy, such being the case of the effects in the field of food security.

### **The technological options**

The technological options for using biomass as a large-scale source of energy can be divided into two categories: biofuels<sup>5</sup> and biopower<sup>6</sup>:

<sup>5</sup> This refers to liquid fuels for transportation.

<sup>6</sup> Electric or mechanical power that is generated on the basis of biomass and that in the form of electric power may or may not be used by the power grid.

In countries like Brazil both categories of energy are produced on the basis of biomass, basically employing sugarcane; the biopower is generated to supply the needs of the production of sugar and ethanol and the surpluses are delivered to the electric power grid. This turns the generation of bioenergy in Brazil into a very efficient activity in energy terms. Brazil and the United States are the leaders in the production of bioethanol. The latter country employs corn biomass in a process which, in terms of the balance of energy, is less efficient than the Brazilian one, but which generates interesting by-products such as a paste with a high protein value for animal fodder. Another world leader in the production of energy on the basis of biomass is Germany and the fuel it produces is biodiesel.

Although the world's two main producers of bioethanol on a large scale have strongly tipped the scale toward those two raw materials, bioethanol can be produced on the basis of a great variety of crops with a large component of sugar or starch. With the first named, the simplest path can be followed: milling, pressing, fermentation and distillation. With the latter, additional prior steps of liquefaction and saccharification are required. By the latter path the United States has clearly become the world's largest producer of bioethanol since 2005. Although it is a controversial matter, the demand for corn for this purpose has generated imbalances in the prices of grain in the world and in the specific case of Mexico has provoked an escalation in prices in late 2006, in 2007 and thus far in 2008.

The price increases haven't taken place only in grains but also in oilseed crops. This has caused sights to be set on the so called second-generation biofuels – namely those whose raw material in the case of the production of bioethanol is lignocellulose. This option – a technically feasible one – has been seen by some as the panacea in the face of the imbalances and the situation of food and environmental crisis triggered by the biofuels that are currently being produced in the world, also known as first-generation biofuels.

Second-generation biofuels employ lignocellulose as raw materials and, prior to fermentation, require additional steps to turn cellulose and hemicellulose into their component sugars (glucose and xylose), steps that are significantly more difficult and costly than the passage from starch to sugars in grains. Nevertheless, the production of cellulosic bioethanol requires carrying out serious R&D efforts before it is employed in an expanded manner on a commercial scale. It is important to stress that several plants already exist in the world that operate on a pilot scale.

### **The situation of oil in Mexico**

The analysis of the Mexican energy situation constitutes a complex problem involving aspects that are political, economic, environmental, of competition for agricultural resources for food and for energy, etc., with the participation of diverse actors with major economic power such as *Petróleos Mexicanos* (Pemex), which has operated as a governmental monopoly in the production of oil and its by-products since oil's nationalization in 1938. Pemex is the main actor in the country's obtainment of oil income and also generates added value over the extent of the production chain.

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Pemex has been a large world producer of oil; in 2006 it exported 1.96 million barrels per day (mbd); since then its output and exports have begun to shrink, as seen in Table 1. This reduction is mainly due to the decline of the Cantarell field, the output of which dropped from 2.2 mbd in 2003 to 1.05 currently. It is estimated that by 2012 the total production of Mexican crude could fall to 1.4 mbd.

In a paradoxical manner for a large oil producer, Mexico faces the situation of being a rising importer of fuels, such as gasoline, diesel oil, turbosine and natural gas, as can be perceived in Table 1. These imports of fuel have increased substantially over the last 3 years.

Table 1. Production, exportation and importation of oil products in Mexico (2002-2008)

Year	Production mbd	Exportation mbd	Importation	
			Gasoline tbd	Other fuels tbd
2002	3.585	1.790	89.7	243.6
2003	3.789	1.844	54.5	199.9
2004	3.825	1.801	94.9	234.2
2005	3.760	1.838	169.8	333.7
2006	3.683	1.959	204.7	368.9
2007	3.147	1.704	308.1	495.9
2008	2.847	1.454	334.5	539.5

mbd: million barrels per day  
tbd: thousand barrels per day

Source: Pemex Statistics

It should be stressed that Pemex delved into the U.S. debt markets as of 1996 and that as a result of this, in 2002 it adopted the definition of proven reserves of the entity regulating stock exchanges in the United States. This modified the amount of proven reserves significantly downward. Despite this, production increased, reaching a maximum in 2004, as is shown in Table 1, to decline as of that point.

Oil income is collected through a taxation system that the government applies to Pemex activities; oil income has high volatility owing to the fluctuations in oil prices on international markets, and depends on a non-renewable resource whose proven reserves/production ratio, it is estimated, will last less than a decade. The above acquires greater significance if it is taken into account that since its nationalization the oil industry has played a highly important role in the financing of the Mexican State; Pemex's share of total public expenditure represented 37% in 2007, and attempting to modify this situation has generated much tension and social mobilizations.

Another aspect that renders the establishment of new policies related to fuels difficult is that their consumption is highly subsidized – before the exchange rate became so volatile it was estimated that in 2008 the subsidy for gasoline and diesel oil reached 19.5 billion dollars<sup>7</sup>. In fact, the subsidy for fuels, natural gas and electricity takes up almost 40% of the total income generated by oil production.

<sup>7</sup> Of the subsidy, 64% is allocated to gasoline and diesel oil.

Consequently, what is required is a comprehensive reform with a long-term vision. This year the presidency sent Congress an initiative to carry out far-reaching changes in Pemex to allow the above-mentioned situation to be solved. This initiative is called the Energy Reform and is very far from having attained a consensus on how to establish a strategic plan to improve Pemex's operation and obtain resources for investment.

The above makes it plain that the country needs to reflect on what energy security means and to incorporate that concept into the formulation of public policies and into the role that alternative sources of energy are called upon to play.

In this context the strategies regarding renewable energy in the country aren't clear. February 2008 saw the approval of the Law on Promotion and Development of Bioenergy, which has been a detonating factor, both for the government and for the private sector, as regards proposing activities in the area of bioenergy. In March, a commission was formed, constituted by 5 government secretariats; three of them (those for agriculture, energy and the environment) aren't playing a role in the coordination/managing of activities, instead having specific goals and programs.

In the same way, in some state governments and in the private sector several industrial projects have been financed in the field of biofuels, but the information comes from the media and isn't very precise. The perception exists that Mexico is entering the field of biofuels without a careful and critical evaluation of their benefits and consequences, as regards either their production or their use. In fact, neither has a strategy for their distribution been established in Pemex (González y Quintero, 2008).

### **The relationship between biofuels and the recent changes in food prices**

Food prices are at their highest level since the 1970s. In 2006, the foodstuff prices index calculated by FAO rose 9%; in 2007 it grew 24% and in the months so far in 2008 an increase of close to 40% has been accumulated. Thus, food prices are believed to have experienced a rise of 87% between 2005 and February 2008. Within this period, grains head the price rises, recording a hike of 165%. They are followed by edible oil and fat, with a rise of 150%, and dairy products, with a 92% increase in their level (FAO, 2008; REDPA, 2008).

Among food crops it is basic grains – wheat, corn and rice – that impact substantially on the food baskets of the different countries, particularly for the population with the lowest income, namely the people devoting the largest share of their income to the food heading.

Among the price increases the most significant one took place in wheat, whose price index reached, in the first nine months of the current farming cycle<sup>8</sup>, an average that was more than 91% higher than that of the same period of 2006/07. In that same time span, the corn price index rose 23%, but this constitutes a relatively moderate increase after having risen 45% in 2006/07. In the first three months of 2008 the index of rice prices established an average that was 46% higher than that of the same period of 2007 (FAO, 2008).

The current food situation cannot be attributed solely to one cause such as might be the production of biofuels on the basis of food crops; rather, it obeys a complex of

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<sup>8</sup> Ranging from July 2007 to March 2008.

factors that have unfolded simultaneously within the global setting, biofuels undoubtedly among them. The diverse analyses establish the following facts<sup>9</sup>:

a) World demand for agricultural products is affected by the rise in consumption by the emerging economies. Indeed, countries like China, India and Russia have increased their demand for meat protein and (REDPA, 2008).

b) The world supply of foodstuffs has diminished as a consequence of natural phenomena, droughts, tropical storms, hurricanes, etc.

c) Consequently, food stocks have been reduced, as shown in Table 2:

Table 2. World: Total grain stocks  
(millions of tons)

Grain	2005/06	2006/07	2007/08	Variation: 2007/08 compared to 2006/07 (%)
Total	469.8	425.6	402.1	-4.8
Wheat	179.5	159.1	144.4	-9.2
Corn	185.6	162.1	157.1	-3.1
Rice	140.7	104.5	103.5	-0.9

Source: FAO, 2008

d) The increase in oil prices has impacted on the prices of farming inputs such as fertilizers and agricultural phytosanitary products, energy and transport costs (REDPA, 2008).

e) The increase in the prices of fossil fuels led to an upturn in investment in biofuels and alternative energy sources. Nevertheless, the production of biofuels in the world is profitable by virtue of the subsidies and incentives enjoyed by renewable energies.

In relation to corn for producing ethanol, it has been suggested that the allocation of the grain for this purpose has caused the increase in its price. Although this has been a factor to take into account, the reasons for the increase are more complex and need to be seen in perspective. There are links between the market for corn and that for soy. In the spring of 2006, the soy market had the better outlook, for which reason the area sown to corn diminished by 3.5 million acres. Combined with reductions in yields, the production of corn fell 3.5 million bushels. The consequence was an increase in corn prices. Despite the reduction in the production of corn in the U.S., the use of this grain for the production of ethanol increased to 2.1 billion bushels in 2006/07, from 1.3 billion in 2004/05. The ethanol industry hasn't been the only source of additional demand, since U.S. corn exports, which were of 1.8 billion bushels in 2004/05, rose to 2.1 billion bushels in 2005/06 and 2006/07, and it is forecast that they will rise to almost 2.4 billion bushels in 2007/08. (Pfuderer and Del Castillo, 2008:19).

<sup>9</sup> World Bank, Economic Commission for Latin America and the Caribbean (ECLAC), United States Department of Agriculture (USDA), United Nations Food and Agriculture Organization (FAO), Organization for Economic Cooperation and Development (OECD), Latin American and Caribbean Economic System (SELA). (REDPA, 2008).

These authors add that although corn is among the products that are currently employed in significant amounts in the production of ethanol, it is wheat that has experienced the largest price increase. The explanation could be that with an increase taking place in the price of wheat, demand for wheat and rice rises, since they are substitute products in some markets.

The industrial use of grains has risen; the expansion is mainly due to the accelerated increase in their use as raw material in the production of biofuels. According to forecasts, in 2007/08 it will approach 100 million tons, among which corn will represent a volume of at least 95 million tons. In 2007/08, the United States is expected to use at least 81 million tons of corn for the production of ethanol, 37 percent more than in 2006/07 (FAO, 2008).

f) The alarmist statements that have imbued the phenomenon with the connotation of a food crisis affect agents' expectations, heightening demand and creating situations that foster speculation. In actual fact, the current situation is characterized more by the expectations of certain agents than by conditions of scarcity caused by drops in supply or abrupt rises in the demand for foodstuffs (REDPA, 2008). This climate of uncertainty has worsened owing to the world financial crisis that began in September this year.

g) The latter factor is linked to the previous one and consists of the after-effects of the mortgages crisis, which created conditions for a massive withdrawal of speculative investments with regard to the market for farming commodities (REDPA, 2008; Rubio, 2008). Indeed, the crisis in subprime funds favored that shift in investments.

### **Description of Mexican agriculture**

The subject that concerns us would be unintelligible without providing a brief description of Mexican agriculture over the last 25 years.

The aim of Mexican agricultural policy in the mid-1980s was the elimination of subsidies to producers. The prices of inputs provided by the government, i.e. power, water, credit, fertilizers, etc., ceased to have any subsidy. Additionally, prior to the launching of the North American Free Trade Agreement (NAFTA), the opening up of trade in farming products had already been launched. The final impact on prices was their alignment with the international prices for most farm products.

The reduction in economic and human resources – since technical assistance services were withdrawn – for semi-commercial and subsistence-level producers generated a technological involution among seasonal producers, which, along with the reduction in the prices of agricultural products, led to a rising increase in the migration from the countryside to the city in the interior of the country and of rural workers to the U.S. It is estimated that as of now 25 million Mexicans have over the course of history migrated to the United States.<sup>10</sup>

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<sup>10</sup> México is a multi-ethnic country, but also a binational people. Because if ten million Indians make us multicultural, twenty-three million fellow countrymen in the United States make us undeniably multinational. One of every five Mexicans lives in the U.S. and one of every two among those who still remain here has family members there. Thus, of every three Mexicans with a job one works on the other side. If to this we add the million *maquila* workers, who are paid in pesos but produce in dollars, (...) we shall have the portrait of a deep-going demographic and job overlap (...) (Bartra, A., 2005)

While the employed population within the whole of the Mexican economy rose 9.68% between 1998 and the first quarter of 2007, in the agricultural sector it diminished 23.97%, going from 7.5 million people to only 5.7 million (González and Macías, 2007:69).

Among other consequences there is the reduction in earnings for the commercial sector and a loss of markets due to the increase in imports.

The food self-sufficiency of the 1960s and 70s has been left far behind. As of the mid-1980s imports have increased their share of national food consumption to reach around 37-40% at this time. In some cases, such as that of soy, the ratio of imports to demand reaches 97.5%.

Luis Gómez Olivier, principal policy officer of the FAO regional office from Latin America and the Caribbean, maintains that Mexico is the world's third-largest grains importer, the fourth in oilseeds, the third in fibers, the fifth in meat and number one in milk imports.

At a social level, pluriactivity is noticed among the inhabitants of the countryside, but one which has no relationship with agriculture and is a survival strategy rather than an improvement in their income. The feminization of agricultural work has also taken place as a consequence of the migration of males of productive age and the aging of producers, to the extent that in some villages the only inhabitants are women, children and old people<sup>11</sup>.

The application of the economic model centered on market forces and with little government participation in the economy has resulted in winners and losers – fewer of the former than of the latter. Agricultural productivity has dropped and farming economic growth has been either nil or negative.

Although the increase in agricultural prices constitutes an opportunity for the development of production and of exports, this doesn't happen in the case of Mexico because of the production conditions the sectors as a whole finds itself in. Only some fruit and vegetable segments are competitive; in the other sectors of land cultivation and cattle raising the situation is vulnerable. There is a time lag for the response of agricultural output to the incentives of better prices, and more so if it involves a dismantled productive apparatus.

With regard to the agrarian structure, although the market for land has been freed, this measure has not had substantial repercussions on productivity or on the growth of agricultural activity and land concentration has been maintained. At the present time the ownership of the land is distributed in the following manner: 3.2 million so-called *ejidatarios* own 84.5 million hectares. Private owners number 1.6 million, with 73.1 million hectares, and 7 million Indians are settled on 27.6 million hectares. The rest of the land is in the hands of what are known as *comuneros*, colonists and *nacionaleros*.

The horizon is even more discouraging if we add the indicators that are offered by the Concurrent Special Program (CSP) for Sustainable Rural Development 2007-2012

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<sup>11</sup> The last Land Cultivation, Cattle and Forestry Census in Mexico was carried out in 1991, for which reason there are no figures allowing the size of the problem to be gauged. The preliminary results of the ninth *éjido* census show that 54.1% of the country's surface, i.e. 105.9 million hectares, constitutes social property. There are 5.7 million Mexicans who are *ejidatarios*, *comuneros* or "possessioners," 1,165,000 of whom are women (INEGI, 2008).

which throw light on the backward productive and social situation of Mexican agriculture. In fact, the average annual median rate of the agrifood Gross Domestic Product is of 0 percent; the annual trade deficit of the sector reaches 2,133 million dollars; 62% of the rural population lives in a situation of poverty; the average income of farming families is of less than 3,500 pesos a month; only 36% of farmland workers enjoy labor services (SAGARPA, 2007).

In the face of this reality the question arises of how the countryside's population has managed to endure and the answer corresponds to the impact that has been produced by the inflow of remittances and the income from illegal crops.

In 2006 these added up to 23,054 million dollars, and since 2005 they have turned into the country's second-ranking source of foreign income. In addition, this situation has tended to intensify in view of the fact that the annual rate of growth of remittances between 1994 and 2005 was of 18.2%, much higher than that of oil income (14.6%), tourism (7.5%) or direct foreign investment (6.5%) (González and Macías, 2007)

Nevertheless, the recession in the U.S. has caused a major drop in this monetary flow. In 2008, remittances record the worst drop in annual terms in history. In August, 1,937 million dollars entered under this heading, which entailed a fall of 12.2% with regard to the flow for the same month of 2007. From January to August, the average annual drop has stood at 4.2%.

### **Importance of corn in Mexico. Production, trade and consumption**

Corn is Mexico's most important crop, not only as its center of origin, but because it is the basis of the nourishment of its population, with strong cultural roots, ones which have endowed the people of Mexico with identity. The origin of the name *maíz* comes from the Carib and means "what sustains life" (FAO, 1993).

Meso-American culture holds corn as a key element in the origin of man, hence the name of "men of corn" for the Maya peoples (FIRA, 1998). The mythical-religious meanings of corn have been thoroughly attested<sup>12</sup> (Esteva, G. *et al*, 2003; FIRA, 1998; Pilcher, J., 2000). The country's different ethnic communities have a culinary variety and specific religious rites sustained by the variety of forms of corn that they maintain.

The use made of the corn plant goes from the use of the grain as food for diverse culinary purposes to the employment of the leaves to wrap *tamales*<sup>13</sup> and the allocation of the stubble for animal fodder. Diverse folk crafts depend on it and the stalks are used in building walls and roofing (FIRA, 1998). However, the basic purpose of the production and supply of corn is to meet human food consumption needs mainly represented by the commercial manufacture of *tortillas*<sup>14</sup>.

Corn's nutritional content is deficient, yet its protein efficiency/cost ratio is only surpassed by that of the egg; for this reason, the consumption of corn in its diverse forms constitutes the basis of the nourishment of the popular classes (Arroyo, G. *et al*, 1989).

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<sup>12</sup> "The native inhabitants of Mesoamerica placed themselves in a cosmological food chain by offering sacrifices of human flesh to maize gods in return for vegetable crops to feed people" (Pilcher, J., 2000:163).

<sup>13</sup> Cake made of corn *masa* stuffed with meats, vegetables or chiles, wrapped in a corn husk or banana leaf and steamed (Pilcher, J., 2000:206).

<sup>14</sup> Griddlecake made of corn *masa* (Pilcher, J., 2000:206).

Mexico ranks second in the world in per capita consumption of this grain, which surpasses that of the majority of other countries by an order of magnitude<sup>15</sup>. We Mexicans eat corn in at least 600 different ways and it is grown by a large number of producers with different levels of technology, but the majority are small producers who plant corn for their own consumption without regard to incentives and economic yields, since it constitutes insurance in the face of economic uncertainties.

### **Production systems**

The differentiation of producers may be carried out according to different criteria: system of land ownership, conditions of production as regards irrigation or seasonal conditions, or economic aspects relating to the destination of production. Considering this latter factor the production systems of corn are two: commercial and for self-consumption

In the first case, production is sent to market; it is based on an intensive production model employing machinery, certified seeds, agrochemical inputs and services. In some regions there is irrigation and in others cultivation is seasonal. The majority of the production is carried out in the states of the center and north of the country (Sinaloa, Sonora, Chihuahua, Jalisco). One of its main problems involves marketing, since the harvest is concentrated in a very few months and this exerts pressure of the sales prices, in addition to the fact that the distances from the consumption centers increases transportation costs and this diminishes its competitiveness vis-à-vis the prices of imported corn. The average yield is of 8 to 10 tons per hectare and the destination of the output is the market.

Traditional production is mainly aimed for self-consumption and only the surpluses, when there are any, are sold on local markets. Production is based on family labor, with the employment of draft animals; the seed comes from the selection made in the previous harvest or from exchanges with other farmers. The employment of inputs and services is deficient especially in remote rural areas and ones with little infrastructure. Production is largely carried out in lands with seasonal output. This system is located mainly in the country's central and southern region (Puebla, Oaxaca, Guerrero, Chiapas).

On the basis of his relationship with, and knowledge of, nature, peasants incorporate environmental criteria in their production decisions, in addition to social and cultural ones such as the plant's behavior during the storage of cobs or the grain, the ease with which the grain is removed from the cob, the softness of the *masa* (dough), the color and taste of the *tortillas*, the possibility of making other products and the yield of the corn in the feeding of the yard chickens and hogs or of the stubble for cattle. As it is difficult to satisfy all these criteria in a single plant, usually two or more varieties are employed having different features – white corn for *tortillas*, red for special stews, yellow for chickens.

Since the priority is the supply of food for the family the criterion of quality ranks above that of productivity. The national average for this system of production is of 2.5

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<sup>15</sup> According to FAO statistics, per capita consumption in Mexico between 2000 and 2004 was of 385, 384, 378, 372 and 308 grams per day, only surpassed by per capita consumption in Lesotho in the period 2000-2003 (FAO, 2006).

tons per hectare. In the event, the profitability of the production unit cannot be measured with financial criteria; agriculture, more than a means for living, is a way of life.

This production system encompasses the semi-commercial and non-commercial sectors with 60% of production units; they occupy 33% of the area sown to corn and account for 37% of the national output of the grain (Brush and Chauvet, 2004).

This brief overview of the production systems show us that contradictions exist between the product's cultural importance and agricultural importance. Although the talk is of corn, in actual fact different products are being referred to. On the world market corn is a commodity that finds uses in animal fodder, processed foodstuffs, biofuels, sweeteners, plastics and pharmaceutical products. Its agricultural importance rests on those products.

In the case of Mexico, value is attached to other types of uses for corn owing to its cultural importance: culinary (*tortillas, tamales, atole, tlacoyos, pinole*, etc.), animal feed, religious festivities, crafts and construction material.

In sum, as regards corn's production structure, although there is a diversity of plot sizes and of agronomic conditions that cause this crop to be planted virtually all over the national territory, it may be stated that the purposes sought are basically two in number: the market or self-consumption. The repercussion that the production of ethanol will have will be a function of these goals. The commercial sector attaches priority to productivity and yield and that of self-consumption to quality.

### Evolution of the production of the crop

Below we present the evolution experienced by the production of corn in recent years:

Table 3. Mexico. Corn

Year	Area sown (Ha)	Production (Tons)	Yield (Tons/Ha)	Average Rural Price (\$/Ton)	Value of the Production (Thousands of Pesos)
1998	8,520,639	18,454,710	2.343	1,446	26,688,749
1999	8,495,876	17,706,376	2.472	1,454	25,753,491
2000	8,444,794	17,556,905	2.462	1,508	26,471,880
2001	8,396,879	20,134,312	2.578	1,451	29,216,396
2002	8,270,939	19,297,755	2.711	1,501	28,957,498
2003	8,126,821	20,701,420	2.753	1,618	33,495,114
2004	8,403,640	21,685,833	2.818	1,679	36,401,628
2005	7,978,603	19,338,713	2.928	1,578	30,515,115
2006	7,807,340	21,893,209	3.001	2,011	44,017,362
2007	8,117,368	23,512,752	3.206	2,442	57,417,902

Source: SIAP/SAGARPA with data from SIACON (2008)

Although the area sown show a slight downward trend, the yield has increased and so have prices in the last two years. Nevertheless, the volatility of the international price of corn – which apparently will be its behavior over the short and medium term – influences the uncertainty of the commercial sector. This year, for example, producers who sold before the harvest were able to dispose of their output at 4,800 pesos per ton and those who did so after June sold it at 2,800 pesos per ton, as reported in mid-October by Carlos Salazar, technical secretary of Mexico's National Confederation of Agricultural Producers.

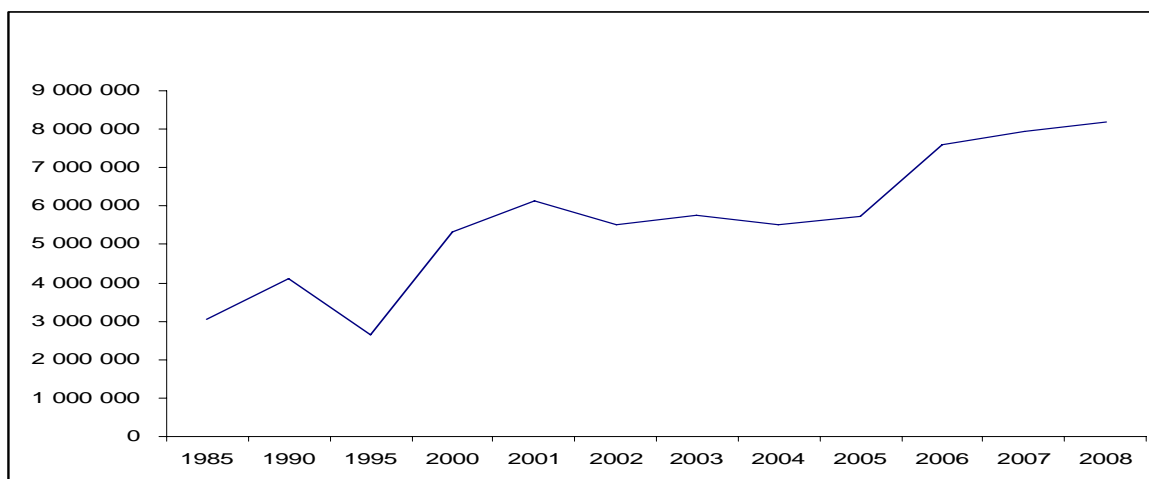
### **Corn imports**

Corn imports from the United States have almost quadrupled since the launching of NAFTA. Most of them are of yellow corn destined for cattle fodder. Mexican production is principally of white corn for human consumption.

During the 1990s, corn tended to become the basic input for livestock nutrition in Mexico, replacing the feed grains previously employed – sorghum and soy – in intensive stockbreeding branches such as hog and fowl raising. Following the beginning of NAFTA, in 1994 the inflow of yellow corn imported from the United States began with a quota of 2.5 million tons and tariffs of up to 200% for amounts beyond the quota, which were to be gradually reduced to reach free imports 15 years later, i.e. in January 2008.

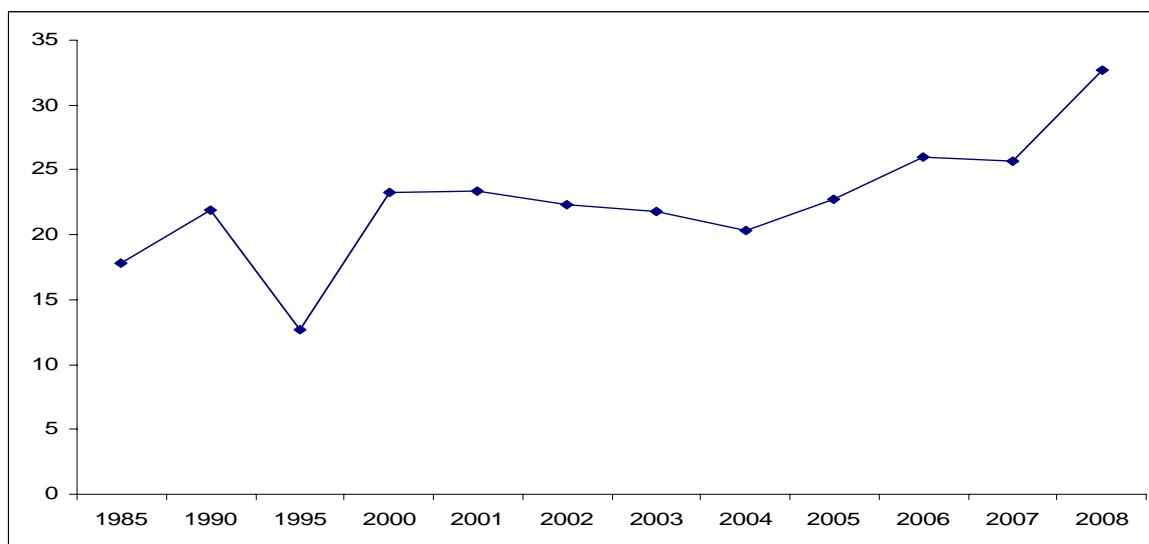
In this period the tariffs were not collected with the argument of the inflationary effect that charging the high figures would cause on the stockbreeding sectors, hindering the population's access to their products (Fritcher and Chauvet, 2005). The pernicious effect of this measure doesn't reside in the tariffs that weren't collected, but in the drop in the real price of these crops on the national market as a consequence of the cheaper imports from the United States. The real price of the grain paid to the producer fell 58% between 1993 and 2006, so that Mexican producers operate under conditions of inequality, their opportunities on the domestic market being limited (González y Macías, 2007:61)

Chart 1. Mexico: Corn imports



Source: SIAP/SAGARPA, Annex 2. Government Report (2008)

Chart 2. Mexico: Percentage of corn imports in consumption



Source: SIAP/SAGARPA, Annex 2. Government Report (2008)

In the 2000-2005 period, imports maintained an amount of between 5 and 6 million tons; as of 2006 a rising trend began, and therewith Mexico attained the rank of second largest corn importing country in the world, after Japan. However, the most worrisome aspect is the index of food dependence (see Chart 2), which went from 18% in 1985 to 33% in 2008, the year of the freeing of the border under the terms of NAFTA.

The supply of white corn for human consumption is guaranteed by domestic production; the imports of yellow corn mainly supply the livestock raising market and that of the starch, edible oil and fried products industries, etc.

In May 2007, Steven Zahniser of the USDA presented the projections up to 2016 for the production of corn and of ethanol in the United States, and the forecast is for that country to reduce the use of corn for cattle fodder and for exports over the next three years, to thus give priority to the production of ethanol. If this is the case Mexico would be affected in its supply of yellow corn, which would impinge on livestock production making its products more expensive.

Despite these limitations on the agricultural sector, the construction of two ethanol production plants began in 2007, to be based on white corn, in the state of Sinaloa, for the purpose of exporting its produce to the states of California and Arizona in the United States.

### **Importance of sugar cane in Mexico. Production, trade and consumption**

Sugar cane is grown in 15 states in the country and it is processed at 57 mills, 13 of which are run by the government.

As regards sugar cane, Mexico has been self-sufficient and in fact exports its surpluses to the United States. Under NAFTA an agreement was set up for a sugar export quota to that country in exchange for the import by Mexico of corn fructose syrup for the soft drinks industry.

Table 4. Mexico: Sugar Cane

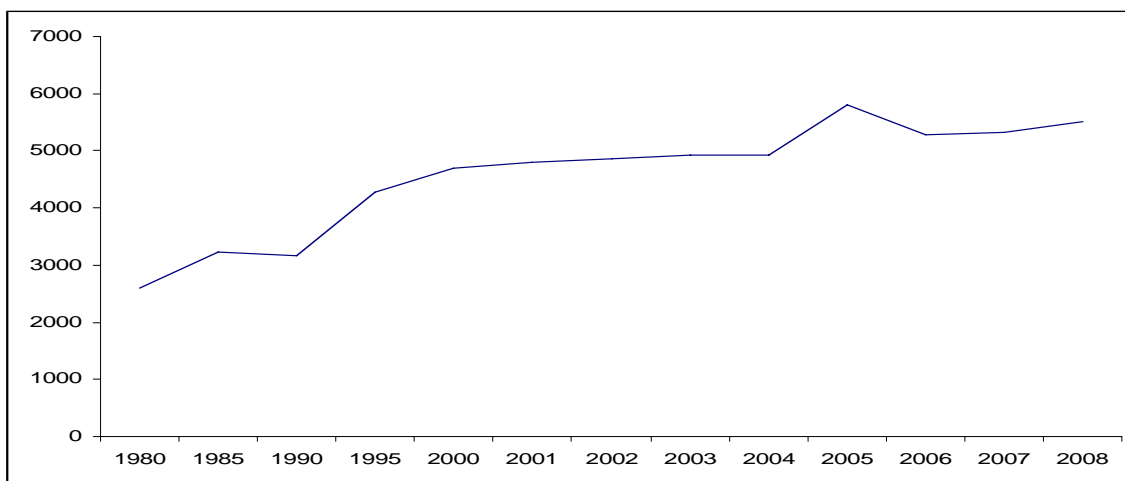
	Sown (Ha)	Production (Tons)	Yield (Tons/Ha)	Average Rural Price (\$/Ton)	Value of the Production (Thousands of Pesos)
1997	670,075	44,465,243	72.330	213	9,478,574
1998	692,430	47,129,814	74.741	222	10,483,672
1999	692,527	45,105,740	70.132	246	11,111,501
2000	667,516	42,373,391	68.534	255	10,821,279
2001	646,692	45,500,563	72.948	289	13,163,234
2002	663,861	45,635,329	72.183	300	13,671,433
2003	682,270	47,483,985	73.687	314	14,899,057
2004	701,167	48,662,243	74.646	329	15,988,736
2005	707,925	51,645,544	77.108	363	18,763,912
2006	716,863	50,060,254	75.523	372	18,621,685

Source: SIAP/SAGARPA with data from SIACON (2008)

Although this trade agreement has not been free from tensions on both sides, the truth is that the U.S. market has been an outlet for the sale of surpluses by Mexican sugar producers.

Apparent national consumption is of 4.8 million annual tons with a per capita consumption of 47.9 kg per year. Sugar production has experienced the following evolution:

Chart 3. Mexico: Sugar production



Source: National Chamber of the Sugar and Alcohol Industries. Annex 2. Government Report (2008)

The international sugar market is saturated and the industrialists of the sweetener see an alternative in the production of ethanol and the production of energy in order to place the million tons of surplus. It is planned to have 26 ethanol production factories launched by 2010.

However, the obstacles to be overcome are several: the urgent modernization of the mills; the absence of agreements with Petróleos Mexicanos to channel the production of ethanol and with the Federal Electricity Commission for the co-generation of electric power; the fact that the energy balance for ethanol is nowadays negative by virtue of the employment of fertilizers with nitrogen, pesticides and even the power used to pump the water that allows the crops. One must also take into account the contamination of rivers caused by vinasse, a by-product of sugar cane refining<sup>16</sup>.

The calculations of the Energy Secretariat are that the incorporation of ethanol as an oxidizer in gasolines would require 980,000 hectares of sugar cane plantations and an investment of 2.4 billion dollars in the sugar mills. Despite the existence of these limitations, the Brazilians are interested in investing in Mexico, but they are held back by the lack of political will and organization in the energy sector.

<sup>16</sup> In Brazil the vinasse is used to fertilize the cultivation of the cane.

Environmental engineer Rodolfo Lacy of the Mario Molina Center for Strategic Studies on Energy and the Environment maintains that it is possible to produce ethanol in Mexico, but that under current technological conditions it will be inefficient as regards energy and unsustainable from the environmental standpoint, so that producing it under these conditions would imply greater costs than benefits (Reforma, May 10, 2007).

The federal government has established the Agreement for the Modernization of the Cane Agro-industry which offers an input of 1.6 billion pesos to the mills in exchange for the commitment to export 1.2 million tons of sugar and to pay the producer 300 pesos per ton. In the harvest that ended in July several companies lacked the resources to comply with the price fixed by the government and paid 225 pesos the ton, so that the resources have not been channeled to the mills.

### **Impact of the increase in the price of food on the standard of living**

The dizzying rise in the International prices of grain, plus a reduction in the national output of grain in some parts, is worsening food price inflation around the world. Despite the policy measures adopted by governments to mitigate the effects of the transmission of international prices to domestic food markets, the prices of bread, rice, products derived from corn, milk, edible oil, soy and other basic foodstuffs have increased markedly in recent months in some developing countries. The parties most affected by the inflation in food prices are those with low income, since the share corresponding to food in their total expenses is much greater than for wealthier groups. Foodstuffs represent around 10-20 percent of the expenditures of consumers in industrialized nations, but up to 60-80 percent in developing countries. Poor populations in urban areas, along with peasants producing a food deficit, are the most affected groups because their access to foodstuffs depends on the marketplace (FAO, 2008).

In the period from 2000 to 2005, the Mexican population made an average annual current expenditure on the purchase of grain equivalent to 19,142.4 million pesos, 52% of which corresponded exclusively to outlay on products derived from corn. Of the latter figure, 43% corresponded to the purchase of corn *tortilla* and only 9% to other products (INEGI, 2006).

As a consequence of the rise in the international prices of corn; of the already mentioned reduction in the grain's stocks at global level; of the allocation of part of the crop of white corn in Sinaloa to livestock producers and the exportation of the rest, in early 2007 the prices of *tortilla* zoomed between 9 and 15 pesos per kilo, causing the government to have to step in and fix a price of 8.50 pesos (Suárez, 2007)

This measure was not only imposed to control inflation but also because of the social impact of such an increase. Indeed, *tortillas* provide 47% of the population's average calorie consumption and for the poorer strata surpasses 60%; of the rural population, 32% suffers nutrition shortcomings.

Although the crisis in *tortilla* in the first quarter of 2007 appears to have been controlled with the establishment of the price, the current financial crisis constitutes another destabilizing factor for prices.

The emphasis has hitherto been placed on the situation of corn and of sugar cane because they are the food crops that are employed in the production of ethanol by the two world leaders. Nevertheless, to complete this analysis it is necessary to examine the

situation of the other foodstuffs that in an indirect manner suffer collateral effects of the boom in biofuels. In particular, livestock products, since the feeding of cattle employs corn.

### Consumption of livestock fodder

Although the strategy of importing food affected agricultural producers, it had the macroeconomic impact of controlling inflation, by allowing consumers access to cheaper goods and services than those produced on the domestic market.

As regards the consumption of products of animal origin, chicken and eggs are the widely consumed protein sources. Mexico is the country with the largest consumption of fresh eggs in the world, with 21.7 kilos per inhabitant per year in 2008.

In 2007, the apparent annual per capita consumption of meat and related products was as follows: beef, 12.6 kg; hogs, 10.1 kg; fowl, 29 kg; cow’s milk 152.7 liters per inhabitant per year (CNG, 2008).

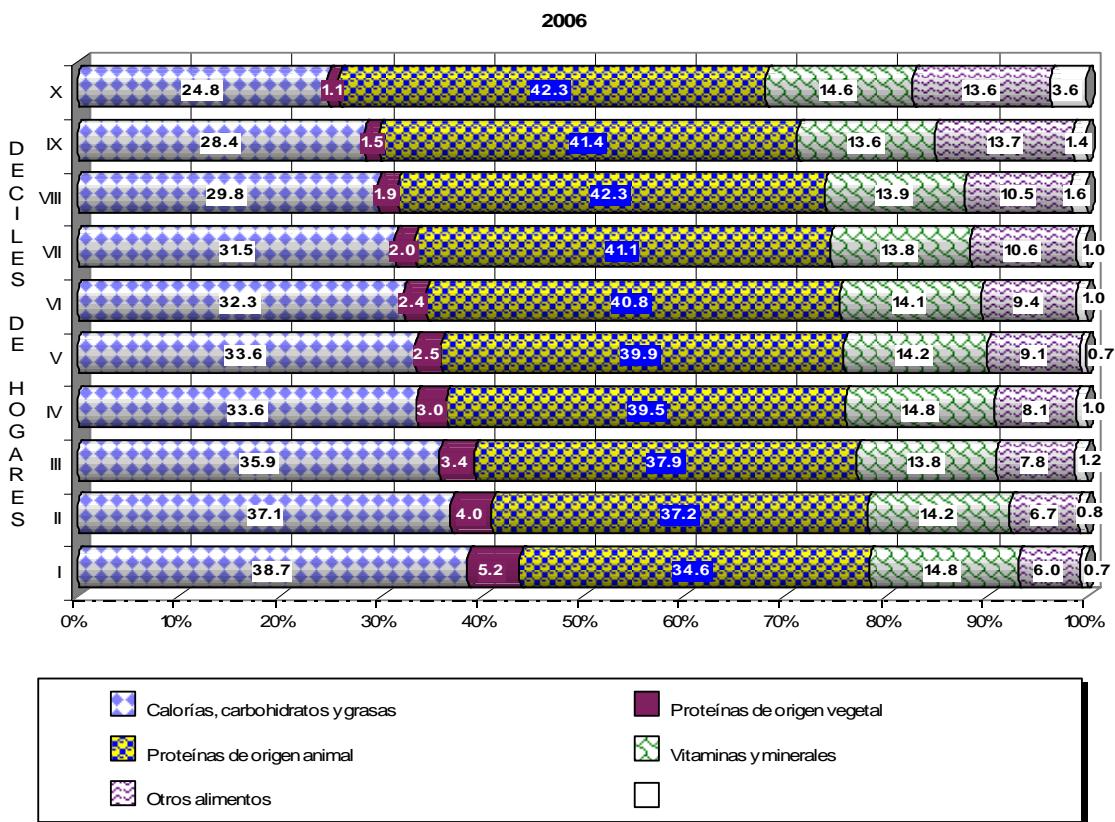
Food dependence as regards livestock products is made clear on considering the percentage of imports in apparent consumption, which in 2007 reached the following figures: beef, 29.6%; hog meat, 31.3%; fowl 18.4%; eggs 0.2% and milk 40%.

Chart 4 shows the monetary current expenditure on food and beverages consumed in the home for each decile of homes per type of nutrients in 2000 and 2006.

The comparison of food expenditure between 2000 and 2006 shows that at family level the origin of the protein was modified, that of vegetable origin diminishing and that of animal origin increasing. For the deciles of medium and high income the outlay on animal protein dropped, but that on other foodstuffs rose.

The heading under which no change occurred was that of grains for deciles I and II; these constitute 40% of the diet intake, while, on the other hand, in deciles VIII to X they don’t surpass 30% in the six years analyzed.

From these data it can be inferred that the greatest food expenditure for the deciles of lowest income tends to be of carbohydrates which are normally priced lower than the



This consumption of food finds itself threatened by the recent events involving a lowering in oil prices which imply a reduction in foreign currency for the purchase of foodstuffs on the international market; by the potential restrictions on corn exports by the United States; the increase in unemployment, and the pressure of the migrants who return in the context of the financial crisis.

The analysis carried out up to this point leads us to state that the food crisis hasn't yet been felt in Mexico, but that the worst is certainly yet to come, given the vulnerability of the economy in general and of the agrifood sector in particular.

### **Social inequality**

The national priorities, at the discourse level, are the reduction of poverty, the promotion of employment and the reduction of emissions into the environment. At the level of the facts, however, the actions that attest to social inequality are others.

The least protected sectors – in rural areas — maintain their consumption of energy from traditional energy sources, such as firewood, for example, the negative effects of which for health and for the environment have been recognized at international and national level. Even the use of hearths at ground level, instead of employing a stove, impinges on the human dignity of such people.

Modern bioenergy is out of their reach, both for consumption and for generating it. In some forums it has been argued that small-scale farm producers might find in the production of biofuels an important participation that could reduce the poverty in which they live. This, however, isn't feasible because, given its scale, the agricultural product they might be able to offer would be expensive, and what the energy industry seeks is an inexpensive raw material – so that the peasant couldn't provide it with either the volumes or the prices it requires.

This situation might change as progress is made in the certification efforts in the field of biofuels that are currently underway<sup>17</sup>, in which value is given to social and environmental aspects and not only to economic ones.

In Mexico, efforts regarding modern bioenergy were initially channeled toward large-scale producers, following the U.S. pattern of ethanol on the basis of corn and the awarding of subsidies, without noticing the problems of food security that this entailed. Social and political pressures were felt in the face of the decision to allocate the best lands to produce ethanol for export<sup>18</sup>. Although it has been stated that this path will no longer be backed by the present administration, the fact is that the plants authorized will operate anyway.

The production of biofuels implies a competition for the use of resources — land and water — between the biofuels and foodstuffs. A recent study by the OECD suggests that the U.S., Canada and the European Union would require between 30% and 70% of

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<sup>17</sup> This refers to the global principles and criteria for the sustainable production of biofuels known as the “zero version.” Federal Polytechnic School of Lausanne, Switzerland.

<sup>18</sup> In October 2006, under the administration of Vicente Fox, backing was given to the construction of two ethanol plants in Sinaloa. SAGARPA gave the government of Sinaloa 75 million pesos to guarantee that farmers would supply the future plants with the raw material, corn or sorghum (Chauvet y González, 2008).

their current cultivated area if they intend to replace 10% of their consumption of fuel for transport by biofuels. This situation of competition for resources could be extrapolated to Mexico, which would deepen its food vulnerability (Pfuderer, 2008).

A short-term threat stalking the quality and amount of Mexicans' basic food basket is the use of corn for the production of ethanol by the U.S., which as earlier pointed out could result in a drop in corn exports toward Mexico, which would translate into shortages and/or cancellation of purchases of inexpensive corn by the cattle feed industry. That is to say, the consumption of carbohydrates for food would increase vis-à-vis the intake of animal protein with consequences for health reflected in obesity and diabetes.

Lastly, the policy toward energy products prevails with regard to social policy. The economic policy followed by the current government zealously watches over the inflation rate and it has therefore, in the face of the events described above, applied subsidies to gasolines, natural gas and diesel oil. The amount of this support in 2007 was of 115 billion pesos and in 2008 it is rising to 200 billion pesos. For the Opportunities program for fighting poverty, 35 billion pesos were allocated in 2007, and 38 billion in 2008. This proves the incongruence between the policies announced as having priority and the actions carried out in practice, since the subsidies allocated to economic policy are much higher than those to social aims, as these figures show.

## Conclusions

Unlike the first-generation biofuels and their recent association with the food crisis, the possibility of using lignocellulose resources has generated very positive expectations for second-generation biofuels in terms of a renewable energy that does not compete with uses for food, of a reduction in greenhouse gas effects, of possibilities for rural development, etc. However, these positive visions with regard to second-generation biofuels must not be considered as a given, but must be evaluated case by case and the necessary policies implemented that support those expectations. It goes without saying that the formulation of policies must be based on broad social participation.

In the case of Mexico, those expectations are nevertheless inscribed within the trajectory generated by the production of first-generation biofuels in the world, in terms of the necessary scales of production, possible lignocellulose resources employed, product standards, etc. However, the need exists to develop supply markets for those resources, as well as the need (¿and opportunity?) to review trajectories that could contribute effectively to the rural, social and economic development of the country. It is important to consider that the shift to a more sustainable production of energy via fuels of lignocellulosic origin cannot be regarded as a *fait accompli*. If progress is desired in the production of bioenergy in the country in a sustainable manner this goal should be clearly established goal in policies and in efforts to develop the markets for those products.

The way in which bioenergy has been developed in the world has led to its representation as the two sides of a coin: traditional and modern – with a modernity that is translated in terms of large scales of production. But what is it that the country needs? The level of replacement of fossil fuels reached in Brazil? The production levels attained by the United States using a raw material that in Mexico clearly competes with its use for food? Allocating its best lands in terms of infrastructure to the production of the raw

material, as in the case of the plants authorized for first-generation biofuels? Using lignocellulose resources originating in industrial activities that already have other uses?

The above are some of the considerations that haven't been taken into account in the diverse actions implemented in this matter in the country, R&D included. The recent food and energy crisis has generated concerns in Mexico of very diverse kinds, but the perception exists that they are not being comprehensively broached, nor does any detailed analysis exist of the effects of moving forward, or not, toward certain options. The thought necessarily arises that the country – like others in the world – is paying the price of not having implemented policies related to national food security.

In the case of biofuels two positions stand out: one that favors them for being a better source of energy, for their renewable nature and for the possibilities they offer for rural development; another that opposes the production of biofuels because of the competition that may take place in agriculture between resources for food and for energy, because some of the biofuels do not constitute an adequate response from the standpoint of climate change, etc. Independently of this polarization, diverse biofuels projects are being implemented in the country about which little clarity exists, as already pointed out, as regards not only their possible effects but also the government backing that is being channeled (González y Quintero, 2008).

It is therefore necessary to carry out a more detailed analysis, since the possible effects of biofuels vary depending on their type, on the raw material employed and on the associated agricultural practices, on the way in which they are produced, etc. Greater public participation and dialogue are required to identify desirable technological options to guide the biofuels research and development process in the country, but the generation of agreements is no easy task either.

In order to move forward on the above it is necessary to use a different metaphor than that of the sides of the coin, since the latter constitutes a “metaphor of a discrete nature” that additionally fosters polarization. Therefore what is needed is a “metaphor of a continuous nature” that allows each side to be identified as an extreme of a continuum of intermediate technological alternatives; a continuum that, far from being linear, admits feedbacks that are the fruit of the co-evolution among technological options and social actors actively participating in guiding the technological alternatives toward goals with greater social benefits.

The possibility that lignocellulosic biomass be used in the production of second-generation bioenergy can become a probability, in a medium and long-term future; but whether this type of energy can contribute to social development and to diminishing inequality will depend on how it is produced, converted and used. It is necessary to establish criteria that take the different dimensions of sustainability into account, such as carbon balances, contamination of water, soil and air resources, biodiversity, and the additional incorporation of the human, social economic dimensions of sustainability such as health, gender equity, energy and food security and individuals' means of subsistence. The challenge is to move forward in the scaling of bioenergy on the basis of lignocellulose resources without losing the contribution of this option to the different dimensions of sustainability.

Food and energy security can be strong promoters of sustainable rural development; it is necessary to find the elements of overlap between both elements and not to place them in opposition. Lignocellulose materials, be they agricultural waste, by-

products of other activities or purposely produced, require R&D and the adaptation of the knowledge acquired. The leading countries in the obtainment of ethanol (U.S. and Brazil) have generated a very strong technological momentum toward the production of first-generation ethanol, based on their strengths (type of raw materials available, type of energy produced, type of consumption market, etc).

In Mexico the framework for the analysis must be a different one. The Brazilian market uses a cellulose material that is a by-product of a very efficient major industry (bagasse) to burn it and generate thermal, mechanical and electric energy for the production of first-generation ethanol; in this regard, ethanol from cellulose has to compete with that of the first generation, and the lignocellulose raw material, even that which is generated when the cane ceases to be burned, can have other uses in the direct generation of energy.

The production of biofuels in the United States has also consolidated around a raw material whose utilization in Mexico clearly affects food security (white corn, agricultural lands with better infrastructure, farming practices that are intensive in the use of resources). With rising imports of corn, the utilization of lignocellulosic materials related to the latter is going to be problematical and will face opposition from diverse population groups. One possibility could be the use of corncobs derived from the production of flour, but it would be necessary to consider their current alternative uses.

An important share of lignocellulose materials in the country have an alternative use against which it is necessary to compete, or is so disperse that its collection is not easy. The market for lignocellulose materials must consequently be developed; some criteria are mentioned below in this regard:

The development of what energy products/services is desired on the basis of lignocellulosic materials?

It is urgently necessary to provide alternatives for energy products and services that are less contaminating and harmful to health in rural areas of extreme poverty; current lignocellulose materials need to be modified and made more efficient, etc.

Progress must also be made regarding energy alternatives for liquid fuels, and lignocellulose materials may have an important contribution to make toward the latter at small, medium and large scale, in both urban and rural areas, but it is necessary to develop markets for the supply and use of biofuels, being careful that their cultivation doesn't divert good quality land. In addition to the manufacturing technology.

If progress is achieved in this regard it will be possible to evaluate the contribution of lignocellulosic materials to energy security and their effects on food security, as well as on the mitigation of social inequality, case by case, beyond any zero-sum game.

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