Genetic diversity of food plants in Mexico

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Abstract:

Mexico is center of origin of some important food crops. In this paper I will consider maize and beans, as they are the main foods for Mexican population and in both of them there have been problems related to biotechnology's impacts. In the first part of the paper I will describe briefly the high genetic diversity existing in the country. In the second part I will analyze the specific situation of maize and beans and in the third part how new biotechnology, specifically genetic engineering, is having an increasing influence in agriculture genetic resources exploitation. There are different factors which have an influence in a country's success to exploit these resources, like agriculture policies, natural resources, different socioeconomic conditions of farmers, as well as Intellectual Property Rights legislation. In Mexico agriculture is in a very weak position due to trade opening, privatization and State retirement policies. Paradoxically, it is in small peasant production where more crop genetic diversity is found, mainly because poverty conditions of these producers lead them to save seed from one cycle to the other and to a scarce use of agrochemical inputs. On the other hand, powerful multinational biotechnology industry is interested in selling and protecting new transgenic crop varieties. The possibility of an adequate exploitation and conservation of agriculture genetic diversity is strategic for the future human kind food security.

1. Agriculture and genetic diversity in Mexico

1.1. Basic food crops and genetic diversity: the future of world food and the conflict towards plant genetic resources

Since 1980's plant genetic information came into the public spotlight, but the production of maize hybrid varieties, for example, was disputed in USA in 1920s because the yields were poor and they eliminated opportunities of farmers to produce their own seed. The importance of plant genetic diversity as a source to obtain commercial crops was recognized since 1930s, "the necessity to conserve plants from around the world as a 'resource' for plant breeding was acknowledged as early as 1930s. Worldwide collection was controversial, however, and would even result in the elimination of one of the greatest geneticists of the century, Soviet citizen Vavilov" (Pistorius and van Wijk,1999:7). Controversies on crop development in the 1980s differ form preceding ones because they were no longer the exclusive domain of scientific experts. A broad public became interested in plant patenting, genetically engineered food, the degradation of biological diversity and plant conservation. Another new characteristic of the debate is the appearance of the first commercial transgenic crops in the 1990s, so corporations' interests toward genetic diversity in general have increased and these resources are now more valuable.

Concern about plant genetic resources (PGR) and food security was first raised in 1970, when a group of American and European NGOs activists and researchers gathered to discuss about the issue under the aegis of International Coalition for Development Action (ICDA). Seed (and so genetic diversity) was a major concern, specifically considering that the genetic base of food supply was quickly disappearing because of industrial modernization of agriculture. Nearly thirty years after, this concern has become more acute, due to major genetic homogenization generated by crop genetic engineering. The book named *Seeds of the Earth* was elaborated by participants in this meeting and it had considerable reaction in developing countries and within the seed industry. This publication and others that appeared in the 80s (Mooney, 1983; Buttel et al, 1985; Kloppenburg,1988 and Juma, 1989) reflected a new tendency in which civil pressure groups question the benefits of agriculture industrialization and crop development.. The main arguments of this critique (which are still standing) were:

a) The prevailing crop development policies are destroying plant genetic base. Most of the crop varieties used in the "North" are derived from plants that were introduced from the "South". This means that plant breeders of the North must have access to "fresh genes" from the South. The prevailing industrialization of agriculture, that started with Green Revolution hybrids and now with transgenic crops, has implied that agriculture's genetic diversity is gradually being wiped out. Industrialization of agriculture greatly facilitated a process of "genetic erosion" in the South, which can lead to the destruction of the basic resources for future agricultural production

Crop development is based on a South to North "gene drain". For centuries, colonial powers and later Northern industrialized countries have freely collected seeds and plants of landraces and wild relatives of the South. They have been stored in botanical gardens or "genebanks", beyond the control of the countries of origin. In the 70s and early 80s (before UPOV Plant Breeders Rights) these resources (seeds, plants, landraces, wild relatives) were considered a "common heritage of mankind", a public resource. This meant that property and payment questions were never raised. However, they have considerable economic value. They have added billions of dollars to the economies of industrialized countries. The countries of the South, therefore, have never been remunerated for this "gene-drain". In 1990, Jack Kloppenburg (1990:167-168) estimated some examples for USA's agriculture benefits:

-A Turkish wheat variety gave stripped fungus resistance genes to USA's varieties, an estimated contribution of 50 million dollars per year

-The Indian variety that gave sorghum green bug's resistance has produced 12 million dollars benefits per year

-An Ethiopean gene protects USA's barley from yellow dwarf disease, with 150 million dollars benefits per year

-The introduction of Peruvian genes in USA's tomatoes to achieve more solid content, has given this industry a benefits increase of about 5 million dollars per year.

-Soybean varieties developed by University of Illinois using Korean germplasm, have saved for USA's agriculture between 100 and 500 million dollars per year in processing.

b) Multinational enterprises take control of the seed industry. A major concern is the effect of crop development privatization. Since the 70s agro-chemical, pharmaceutical and food processing corporations have become interested in the seed sector and were taking over the family-based seed firms. This has lead to a situation in which a few multinational enterprises have taken control of the world's food production. The new seed companies would privately hold unique seed collections. They use them to produce both high yield varieties and transgenic crops, contributing therefore to "genetic erosion" Further more, public research institutes are now compelled to patent their genetic resources. Mexico based CIMMYT (International Research Center on Wheat and Maize, from CGIAR system), communicated to press in 2000 that it was going to start a patent policy concerning their gene bank and crop development research (Pérez, 2000)

c) Intellectual property rights (IPR) hinder transfer of crop development technology to developing countries. Plant breeding, the propagation and marketing of new plant varieties have been being hindered in developing countries because of intellectual property rights granted to plant breeders on their new creations. Even though the new varieties contained genetic information freely obtained form developing countries, unauthorized exploitation of these varieties has become increasingly difficult. Another impact of IPR have been cases of biopiracy, as the recently known Mexican yellow-bean case.

1. Genetic engineering, agro-biotechnology corporations and agriculture genetic diversity

The statements distributed by CGIAR (Consultative Group on International Agriculture Research) in the eve of United Nations Conference on Environment and Development (Rio de Janeiro, 1992) made it clear that "plant genetic resources have a key role in world trade". The document described some examples about local varieties of developing countries represented a possibility to explore niche markets. This has become an official position of CGIAR system concerning the subject. Paradoxically, developing countries are not the ones who have received benefits from local varieties and agriculture genetic resources, but the private crop development industry of industrialized countries.

Since the middle 1990s, chemical, pharmaceutical and food companies have been making unprecedented take over of plant breeding and genetic engineering firms. This increase of private investment in crop development has been accompanied by a world-wide adoption of neoliberal policies and reduced involvement of governments in agriculture.

During Green Revolution (1940s and 1950s), the collection of landraces was intensified, which brought forward even a global conservation system: a close connection of seed banks established in most parts of the world. Plant breeders extensively used this system and freely exchanged germplasm in order to breed new varieties.

With genetic engineering arrival the target and means of plant collection are subjected to considerable changes. The plant seems to loose its exclusive position as sole resource for the creation of new plant varieties. For genetic engineers within the crop conglomerates, the pool of genetic resources is much broader than that stored in the seed banks. Apart from plants, all living organisms are potentially useful for breeding, as long as they contain the DNA that encodes for a desired trait.

"If private investment in the genomics industry continues to grow at the current pace, and genetic information of micro-organisms, insects, birds or human blood is screened and stored in 'DNA data banks', will there still be a function for the seedbanks in the future?" (Pistorius and van Wijk,1999:127)

It is also important to regard the position of the suppliers of genetic information. The new broad gene-pool covers genetically diverse biological organisms that can be found in tropical forests and farmers' fields in developing countries, in order to find and identify useful DNA sequences. So, crop development conglomerates have embarked on 'bioprospecting' programs for the identification and evaluation of genetic properties in virtually any organisms. Possible benefits to developing countries and indigenous or peasants involved in these resources management and conservation is a controversial issue.

Transgenic crops: a threat to genetic diversity

Modern agro-biotechnology, which means the use of genetic engineering to design new crops, has in maize one of its main products. Nowadays, specially in USA, considerable surfaces of transgenic maize are being planted. There exist two types: Bt resistant to insects (7.5 million hectares in the world in 1999) and Bt with herbicide resistance included (21.6 million hectares) (James, 1999). Transgenic maize surface had diminished to 9.8 millions of hectares in 2001 (www.isaa.org, 2002).

In ecological terms, this issue highlights the global geographical divide between the countries best able to commercially exploit genetic resources, and those that are the sites for most genetic diversity. The process to obtain a commercial plant variety from a wild one needs years of research and investment. Only those countries that dedicate enough funds to agriculture research are able to decide and exploit plant genetic resources. These conditions are found mainly in industrialized countries. However, the bulk of the world's genetic diversity is located in a group of developing nations, known collectively as the Vavilov Centers of Biological Diversity (Table 1). Moreover, these are also places where, because of biodiversity, potential environmental risks arising from GM contamination are greatest. As noted by Rissler and Mellon (1996: 22): "Genetically engineered crops are not inherently dangerous; they only present problems where the new traits….produce unwanted effects on the environment". The main environmental risks are related to genetic crosses with non-transgenic crops, leading to the appearance of new weeds, plagues and/or the disappearance of landscapes' important crops. Nevertheless the major concern is about the effects on health, allergies and toxicity.

TABLE 1
VAVILOV CENTRES OF BIOLOGICAL DIVERSITY

REGION	ORIGIN CROPS
Central America	Maize, tubercles
Andes	Potatoes, peanuts
South Brazil, Paraguay	Manioc
Southwest Asia	Rye, barley, wheat, green pea
Mediterranean	Oats, canola
Abisinia	Barley, sorghum, millet
Central Asia	Wheat
Indo-Burma	Rice, dwarf wheat
Southeast Asia	Banana, sugar cane, yam, rice
China	Fox tail millet, soybean, rice

SOURCE: Vélez, G. y Rojas, M., (1998), Definiciones y conceptos básicos sobre Biodiversidad, Biodiversidad, Sustento y Culturas, Cuadernillo No.1, Programa Semillas, Bogotá, Colombia

These issues are important concerning Mexico, on of the world's most important Vavilov Centers. Mexico is the center of origin for maize, a fundamental food crop in feeding the human race (Mooney, 1979). In Mexico, agricultural genetic diversity has been reduced progressively for a number of decades, because of the effects of Green Revolution hybrids. Globally, FAO reports that food crops' genetic diversity diminished 75% during 20^{th} century (Greenpeace, 2000:5).

The potential for this to be accelerated through the introduction of GM (genetically modified) crops presents important repercussions for small subsistence peasant production in Mexico. Prospects of genetic pollution could have serious implications for maize within the complex inter-planting practices of small peasant landholders. As I have said before, in Mexico, maize is a staple food linked to cultural identity. It is the basis of subsistence agricultural production, supplying *tortilla* and other foods, as well as feeding livestock. In the State of Chiapas, for example, peasants are considered to be low yield cultivators of maize (their yields are two tonnes per hectare), but this does not take into account that this crop is inter-planted with beans, squash, vegetables and fruits, so these landholders generate total food yields of 20 tonnes per hectare (Shiva, 2000:4).

In the opinion of many NGOs (non government organizations), these cultivation practices are imperilled by the introduction of GM maize. GM pollution can alter the genetic profiles and characteristics of traditional maize varieties. For these reasons, in 1999 the Mexican government implemented a moratorium on cultivation of GM maize, even for field trials. Since 2003 moratorium for field trials was finished. This meant that GM maize imported from the US could be used for consumption, but not for seed. Nevertheless, despite these attempted restrictions, Mexico's attempt to remain 'GM-free' was soon breached.

The reality of the threat of genetic pollution was brought into sharp focus in August 2000 via the 'Starlink' case. GM maize that was forbidden for human consumption found its way into Taco Bell and Kraft products. Moreover, this was revealed not by any regulatory authority, but by the NGO 'Friends of the Earth'. As a consequence, Kraft Foods had to retire 300 products of the market in September 2000, while the owner of Starlink, Aventis, stopped its sales, and the USDA retired 350,000 acres planted (López Villar, 2003). Following the exposure of this pollution, Starlink was also found in USA exports to Japan and Korea. This case underscores the difficulties of containing and controlling the GMO presence, once it has been approved for the market.

2.2. The case of maize: food, culture and genetic diversity

Maize in Mexico. Production and consume

The so called food auto-sufficiency in terms of maize was broken after the long agriculture crisis since the seventies (Rubio,1983; Calva,1988; Tarrío, 1999). In fact, urbanization process brought the increase of meat products' consumption, so a significant part of maize was for forage (this happens until today); in the same way, maize imports from USA for industrial use (oils, for example) and flour products' consumption increased (snacks, flour tortilla)

In this process harvested surface did not have important changes in 1970-1979 and in 1970-1996 it grew only 8.2%. Nevertheless, production per hectare and total production grew in 87% and 100% respectively and population increased too, while imports grew seven times (Table 2). This means that productivity increases were not enough to supply maize's demand. In Mexico maize means half the food volume consumed each year and it supplies the population half the required calories. In spite of this, there is a production deficit and imports are increasing. This is due to agriculture's lack of investment because of restrictive policies.

TABLE 2

MAIZE, Harvested surface, production, productivity, imports

1970-2000

Year	Surface Hectares	Production Million Tons	Kg Hectare	Imports Million Tons
1970	7,479,634	1,194	8.8	0.7
1980	6,766,000	1,829	12.3	4.1
1990	7,338.872	1,994	14.6	4.1
1996	8,050,931	2,239	18.0	5.8
1998	10,915,500	2,300	18.4	3.7
2000	9,411,600	2,108	22.4	5.0
2003	10,880,000	5,104	23.0	5.0

Source: Historical Statistics of México. National Statistics and Geographic Information Institute, 1970-2000

2003:www.inegi.gob.mx/est/contenidos/español/tematicos/mediano/med.asp?t=siap03&c=5048 , June 9th

60% of maize production is for human consumption, approximately 8.5 million tons in 1997 and 10.67 in 2000, including rural self-consumption. Tortilla provides more than half the calories and the third part of proteins consumed. In the rural sector this data are higher: 65% of the calories and between 50 and 70% of the proteins. Recently animal food consumption has increased, specially poultry, 26% of the total consumption (Fristcher,1999). Maize's consumption for animal food grew from 5.9 million tons in 1994 to 6.6 in 2000 (National Maize Industry Chamber, 2001). Maize is present in 57% of the cereals and oilseeds' surface, more than 2.5 million farmers produce more than half the total production. National consume is about 16 and 20 million tons, imports are between 20 and 40% of this. 72% of the farms produce it, they occupy 35-40% of rural labor force and 66% of the cereals surface. Maize generates a third part of the produced value in agriculture. It is basically a rain fed land crop (SAGAR,1997). In 1999

Agriculture Minister reported to press that there were 4 million self-consumption farmers, they all produced maize and beans (Enciso, 1999).

Maize is basically grown by small farmers –92% of them produce in farms of less than 5 hectares- and self-consumption is an important proportion of production (35% of these small farms). One part of this rain fed maize is for selling. In the last decade 11% of maize production was obtained from farms of less than 2 hectares, 31% in farms between 2 and 5 hectares and 29% in farms between 5 and 10 hectares. The most important contribution (60%) is from farms between 2 and 10 hectares. According to Bartra (1998), between 1.5 and 2 million peasants, 45% of the total of farmers in Mexico in 1990 produced maize and other crops both for food and market and another 1.5 million peasants do not produce enough to survive and have to complement with salary work or migrating to Mexican cities and/or USA.

Between 1989 and 1993 production grew almost in 80%, from almost 11 million tons to 18. 2 million, in that moment the country achieved food-sufficiency. For Fristcher (1999), this prosperity was due to government's decision of keeping maize away from liberalizing-opening policies, while frontiers were opened for the other cereals. Protection continued until 1994 ant it had controlled prices which grew and were superior to international price in 60% and 80%. CONASUPO, the government commercialization agency, acquired 45% of the production those years, more than 8 million tons. This generated a change in farms towards maize, that substituted sorghum, soybean and wheat, specially in the North of the country and its production grew 160%. Irrigated agriculture doubled its surface dedicated to maize between 1990 and 1994. The Northern state of Sinaloa became the main producer, with 2.7 million tons, its contribution to national production grew from 2.2% in 1990 to 15.1 in 1994. Maize production achieved 18 million tons in 1993 and continued this way until 1996, when a policy change happened and it entered in the liberalization process (in spite that in NAFTA it was protected until 2009). Then, maize production returned to be a rain fed-small farmer crop. Since 2001 and until nowadays, Sinaloa maize producers protested because disadvantageous imports.

Maize´s genetic diversity

Maize was domesticated in Mexico between six or eight thousand years ago and in middle-american regions there were once thousands of varieties. Green Revolution generated the loss of a good part of this diversity: form the existent varieties in 1930, now there are only 20% (GRAIN,1996).

In the International Research Center about Maize and Wheat (CIMMYT) collection, Hernández et al (Wellhausen, Roberts, Hernández, 1987) reported there were more than 2000 maize samples and although it is not complete, maybe it is the most numerous maize collection in any country. At least there are represented most of the races that have played a role in the main agriculture types.

There can be recognized at least four factors involved in high genetic diversity of maize in Mexico: 1) Primitive races that exist only like archeological remains in other regions exist in Mexico as living varieties; 2) During certain times in maize's history there have been registered the influence of exotic varieties from South countries; 3) Teocintle (a wild relative still alive in Mexico) has crossed in a natural way in Mexico and near regions from Guatemala. It has introduced new variations in both countries; 4) Mexican geography favors quick differentiation, as it possesses different kinds of isolation factors.

Maize varieties in Mexico are of special interest because of the role they have played in the development of modern and highly productive varieties in America, specially in USA "maize belt". In consequence, Mexican maize varieties' classification is interesting not only for the crop's improvement, but also to genetic scientists and more recently agro-biotechnology industry.

Probably it does not exist a "pure" race of maize, meaning that all individuals are genetically homogeneous. In free pollination varieties probably each plant is slightly different in its genetics from other plants. A race can be defined as "a related group of individuals with enough common characteristics that allow to recognize them as a group" (Wellhausen, Roberts, Hernández, 1987). In Mexico it is possible to recognize at least 25 races, this means that all maize varieties belong to one of them. Maize races in Mexico belong to four main groups: a) Antique indigenous, b) Exotic pre-Colombian, c) Incipient modern, e) Not well defined races, an additional group. Each group has some races.

Research directed to increase food production started in Mexico in the thirties, first as a small department of agriculture research and afterwards in 1945 with a research program of Rockefeller Foundation and Mexican government. This program produced the so called Green Revolution and its objective was to increase food production in the private commercial sector. Small farmers were not considered as they had been before in research programs.

When Rockefeller Foundation retires from agriculture research in Mexico, its approach towards a modern and commercial agriculture remained in the National Agriculture Research Institute, which started in 1961. Most of the research since Rockefeller Foundation times focused in maize and wheat. Maize was the most important crops, with 64.6% surface between 1939 and 1941 (Hewitt, 1978). There were wheat producers who could take advantage of the new Green Revolution technology, while small maize peasant farmers remained in poverty and resource scarcity.

Green Revolution's seeds were hybrids and they could achieve high yields only with irrigation and agrochemicals. The exceptional hybrid's yields occurred only during the first cycle and afterwards they produced less if planted again.

Nevertheless, Rockefeller Foundation experience in Mexico was exported and contributed to generate the international agriculture research system called CGIAR. Part of this was the already mentioned International Research Center about Maize and Wheat in Mexico, founded in 1963, when

Rockefeller Foundation retired from the country. Until now, this center takes advantage of maize genetic diversity in Mexico for its research.

Since 1970 Mexico lost its capacity to supply enough maize for food consumption, as was explained before. Green Revolution hybrids, although not very accessible for small farmers, have been used in some extent. In these regions it is common to save seed from the harvest. Nevertheless, if peasants can buy some of the high yield hybrid seeds, they use and reproduce them and this has an effect on landraces. Maize production in small farms is not considered profitable by government policies, so it is amazing production still exist in these lands. Poverty and the need to harvest at least part of food consumption is an explanation.

Transgenic maize pollution in Mexico

A second episode of GM pollution happened in 2001, when two researchers from the University of California at Berkeley (Quist and Chapela, 2001) published evidence of GM maize in crop samples from Oaxaca (South of Mexico). These results publishing in the journal *Nature* generated a major scandal in Mexico. The National Ecology Institute and the National Biodiversity Commission ordered two of the country's leading research institutions (UNAM and CINVESTAV) to undertake further studies. These studies confirmed Chapela and Quist's findings, although *Nature*, after publishing their results, expressed some doubts. At the time of writing, the results of a further study into this issue have not been published. Nevertheless, the Director of National Ecology Institute has said GM pollution is present not only in Oaxaca, but also in the Puebla. However, more recently (2004), Dr. Amanda Gálvez, president of Inter-ministries Biosafety Commission Consultative Council, and Dr. Ariel Alvarez, a Mexican researcher, declared to press that transgenic pollution is minimum in maize cultivars, as results of the mentioned second research show that in 200 plots studied only in 7.6% of them there was transgenic evidence. Alvarez assumes that this happens because transgenic maize is not as productive as local varieties, so peasants are not planting it (El Independiente, 2004:5).

Biotechnology offers controversial alternatives to Mexican maize's structural, agro-echological and cultural characteristics. The risk aspect implies that this technology may have adverse effects in the crop's genetic diversity, biosafety aspects, intellectual property rights, technological development, etc. In industrialized countries market there exist the two mentioned varieties of transgenic maize. The companies that produce them argue that they increase productivity as they diminish plague losses and they reduce production costs because they need less pesticides. In addition, they protect environment. Their yield increases would make unnecessary to open more lands to agriculture, therefore contributing to preservation (Serratos, 1998).

On the other hand, environmental, peasant, indigenous and some academic groups argument that genetically modified plants are dangerous to echosystems' sustainability, produce genetic erosion and are an obstacle to seed free access, as this is controlled by big multinational agro-biotechnology corporations. Besides, genetic flux from transgenic maize could have unpredictable consequences for the crop's biodiversity.

Besides, it seems that the plagues to which transgenic maize commercial varieties are resistant are not present in Mexican territory and herbicide tolerance would not be accessible to most producers. It is necessary to make rigorous assessments before liberating transgenic maize to the environment and it is urgent to develop technical-scientific capacities for this and a biosafety legislation, that does not exist until now. Nevertheless transgenic maize seed imports are not allowed, there are transgenic grains in imports from USA.

The breaches in Mexico's moratorium on GM maize represent a serious problem with the international regulation of GM food trade. Because of the lack of appropriate monitoring and separation systems, transgenic maize varieties are now spreading in the crop's center of origin, with unknown consequences. On the one hand, this damages the ability of Mexican producers to market their maize as 'GM-free'. On the other, it potentially affects the genetic qualities of maize varieties used by peasants, denying farmers' rights to select and use non-transgenic seeds. Until now, Mexican authorities have not developed an effective response to these problems, although environmental and peasant organizations have demanded an end to GM maize imports from the US, the most probable source of pollution. A group of these organizations has requested intervention from the North American Commission for Environmental Cooperation (CEC), a tri-national commission established in the NAFTA context and this body is currently working on a report that will be published in June 2004.

The evidence of GM maize pollution clearly illustrates regulation problems in Mexico towards biotechnology. There is a lack of government interest to protect both basic food production and maize's genetic diversity, and there are severe contradictions in government institutions. On the one hand, there exists an inter-departmental commission to regulate transgenic crops planting in Mexico that forbids the use of transgenic maize in the country; whereas on the other hand the Ministry of Economics allows transgenic maize to be imported into Mexico for consumption. In turn, Mexico's dependence on maize imports is a consequence of economic policies that have neglected internal maize production for decades (Massieu and Lechuga, 2002), in the context of significant agricultural subsidization by the US and the NAFTA. In contradiction to Mexico's commitments under the *Cartagena Biosafety Protocol*, a Biosafety Law for the country has not been drafted.

It has not been demonstrated until now that eating transgenic food is harmless, but there is certainly a consumers' rejection, specially in Europe, and a demand from certain NGOs that there should be more research about this kind of food's safety before it is sold to the public. What is clear after Star Link and Mexican transgenic maize pollution cases, is that, once transgenic food and seed are commercialized, it is difficult to control it and that countries that are centers of origin of the main food crops should have an adequate biosafety policy.

2.3. Beans: crisis and IPR problems

Alike maize, beans have got an impressive importance in Mexico, as they were domesticated in the territory in ancient times and they are a substantial part of Mexican food. They are present in many agriculture systems. Beans are an important part of a high variety of Mexican dishes and a good complement to maize, as beans have essential aminoacids, as lisin and triptophane, that are not present in maize. Both products are the basic diet by for the majority of Mexican population, who can not buy more expensive food. Together with corn and wheat, beans gave between 70% and 90% of the consumed proteins for the poor families (INEGI et al, 1988).

Nevertheless, beans consume has been decreasing This decrease has not happened in its surface and production volume, it is due to a diet change in middle class population, who have substituted beans for other food.

Since the 80s beans consume is higher than internal supply, so it has to be completed with imports. Mexico is the firs beans importer in the world, while USA are the main exporter. Beans imports cost 134 million dollars per year. 11% of the total cultivated surface belong to beans and 14% of the total farms produce them. Like maize, it is mainly a peasant crop, as it is produced by them in 88% both for self-consumption and selling in the market. Self-consumption means between 18% and 30% of total production. It has a significant effect on employment, as it requires approximately 50 millions labor-days in certain months (August and October) (Ledezma and Ramírez: 1995, 41-42). Beans production is suffering a strong crisis that started in the 80s but has become more acute since NAFTA started, as USA imports, who have lower prices, enter the country and make it unprofitable to produce for national farmers.

Although Mexico is the fifth beans producer in the world, with 7.6% of the total surface and 7.2% of the total production, the country has not achieved auto-sufficiency and depends on imports to satisfy consume. It s a risky production, as it is vulnerable to uncertain climatic conditions (scarce rain and strong cold). Another problem are low technological levels that are an obstacle to increase yields (250 kg/he average). Good quality seeds are scarce. Mexican research institutes have developed some local varieties, based in the high genetic diversity of the crop, but they do not reach producers, who use low quality seeds, sensible to plagues. The main variety cultivated in Mexico is *Phaseulus vulgaris.* There are also poor soils and low nutrition levels, all at the same time.. Approximately 85% of beans production happens in rain-fed lands. Since the 80s Mexico became a big importer specially in 1980 and 1981, with imports about 500,000 tons and in 1990 with 350,000 tons.

TABLE 3

Beans, production and surface. Thousands of Tons and Hectares

Year	Production	Surface
1988	2 279	1 454
1989	2 332	1 377
1990	2 780	1 430
1991	2 608	1 364
1992	2 827	1 321
1993	2 703	1 301
1994	2 891	1 485
1995	2 878	1 429
1996	3 124	1 503
1997	3 015	1 532
1998	2 923	1 483
1999	2 680	1 458
2003	1 061	1 551

Source: 1988-1999: LVII Legislatura, (2000), ¿Cuánta liberalización aguanta la agricultura?, Impacto del TLCAN en el sector agroalimentario, Comisión de Agricultura, P.101
2003:
www.inegi.gob.mx/est/español/tematicos/mediano/med.asp./?t=siap03&c=5048
June 9, 2004

Self consume producers are in 35.4% of the beans harvested land (Rodríguez Gigena,1983). These producers work in less than 10 hectares deficient rain fed farms. Peasants have between 10 and 140 hectares farms, 50.3% of all harvested surface. Entrepreneurs lands are 14.3% of total harvested surface, with farms of more than 140 hectares. So, peasants are the most important beans producers sector. Mostly they use family labor, although they sometimes hire salary workers. They farm in bad rain fed lands, but nevertheless produce a small surplus after satisfying self consume. Their average yield is one ton per year to fulfill food and seed requirements. These self consume level means between 18 and 30% of production volume and allows them to have a small saving for next production cycle.

Beans cultivated surface has decreased in last years (Table 3) due to the crop's crisis. Producers' strategy has been to produce in less land, the one they can afford with their own resources and those from migrants.

Enola bean: a biopiracy case

On January 17, 2000, RAFI (Rural Advancement Foundation International), reported that a US-based company, POD-NERS, L.L.C, was suing Mexican bean exporters, because Mexican beans they were selling in the US infringed POD-NERS' US patent on a yellow-colored bean variety. It was not surprising that the Mexican beans were strikingly similar to POD-NER's patented bean, because POD-NERS proprietary bean, "Enola" originates from the highly popular "Azufrado" or "Mayocoba" bean seeds the company's president purchased in Mexico in 1994. The Mexican yellow beans have been grown in Mexico for centuries, developed by generations of Mexican farmers and more recently by Mexican plant breeders. In 1994, Larry Proctor, the owner of a small seed company and president of POD-NERS, L.L.C., bought a bag of commercial bean seeds in Sonora, Mexico and took them back to the USA. He picked out the yellow-colored beans, planted them and allowed them to self pollinate. After two years, he claimed that he had obtained a new variety and applied for a patent on it. He got US patent no. 5,894,079 on the "Enola" bean variety. The patent claims exclusive monopoly on any *Phaseolus vulgaris* (dry bean) having a seed color of a particular shade of yellow. POD-NERS claims that it is illegal for anyone to buy, sell, offer for sale, make, use for any purpose including dry edible or propagation, or import yellow *Phaseolus vulgaris* of that description. (To be granted a patent, the inventor must meet three standard criteria: The invention must be new, useful and non-obvious). In 1999 Larry Proctor won a USA Plant Variety Protection Certificate (No. 9700027) on the Enola bean variety. The PVP certificate states that the Enola dry bean variety "has distinctly colored seed which is unlike any dry bean currently being produced in the United States" (To receive plant variety protection in the USA, a variety must be new, stable, uniform and distinct.) Later in 1999, Proctor brought legal suit against two companies that sell Mexican beans in the USA, charging that they infringe his patent monopoly. Proctor has initiated legal suits against two companies that buy yellow beans from Mexican farmers and sell them in the USA. POD-NERS is demanding royalties of six cents per pound on the yellow beans entering the USA from Mexico. Because of this, USA customs officials are now inspecting Mexican beans at the border, taking samples from every shipment, and the two companies are loosing customers.

Outraged by the appropriation of Mexican germplasm and legal attempts to block Mexican bean exports to the USA, Mexican government announced in early January 2000 that it will challenge the USA patent on the "Enola" bean variety. The patent challenge cost at least USA $200,000 in legal fees. Mexico's National Research Institute for Agriculture, Forestry and Livestock (INIFAP) recently conducted a DNA analysis of POD-NERS patented bean and the results indicate that the Enola variety is genetically identical to Mexico's "Azufrado" bean. The result of this legal process shows some future trends about possibilities for biodiverse and underdeveloped countries to defend their germplasm, but meanwhile the damage for Mexican bean exports has been done and public funds that could be used to invest in agriculture are used in the legal process (www.rafi.org, 2000).

3. International regulation of PGR

The notion of plant genetic resources as public and free to everyone started to change in the early 80s, when “Group of 77” developing countries began to raise questions about the exploitation of genetic information, in the context of their struggle for a New Economic Order (NIEO) These conflicts intensified because most of the world’s seed banks were under control of OECD countries. The PGR conflict took shape in two FAO resolutions during 1981-1989, concerning the International Overtaking of PGR and the establishment of an FAO Commission on PGR. The resolutions have been proposed by a group of developing countries and both resolutions were adopted by FAO in 1983.

The International Undertaking was a non-binding agreement that provided standards and rules for the conservation and exchange of seeds, plants and plant tissues between countries. It formalized PGR as “common heritage of mankind”. Developing countries have used their majority to develop a very broad definition of PGR and “the result was that the Undertaking considered not only wild plants and landraces, but also commercial plant varieties, legally protected or not, as “common heritage” and thus publicly available for breeders and farmers worldwide” (Pistorius and van Wijk, 1999:10-11).

In FAO in 1989 both developing and industrialized countries achieved agreement concerning PGR in three principles: -First, it was accepted that plants protected under the system of plant variety rights were not freely available. –Second, it was agreed that ‘free access’ to landraces and wild relatives did not mean access “free of charge”, so public and private plant breeders would consider payment for the plants and seeds they collected in developing country territory. –Third, a new type of rights, referred to as ‘farmer’s rights’, was adopted, they were not defined but only justified by referring to the farmer’s efforts for thousands of years in domesticating plants.

Farmers’ rights can probably best be understood as collective intellectual property rights which entitle farmers to receive financial support from an International Fund governed by FAO. However, the contributions to the Fund were voluntary for participating countries so that neither the International Fund nor the Farmer´s Rights concept have materialized. In Mexico in 1996 it was approved a Plant Variety Law inspired in Farmers’ Rights, paradoxically, most of the applications for such protection come form multinational flower production corporations (Secretaría de Agricultura, 1999).

In later years the evolution of PGR conflict was greatly influenced by three other international agreements: a) The Convention on Biological Diversity (CBD), adopted during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 992, b) the agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), concluded in Marrakesh in 1994 and c) the Cartagena Protocol on Biosafety, one of the commitments acquired in CBD in 1992, signed in Kenya in 2002.

The CBD was the outcome of an international negotiation process that originated in public environmental concern in OECD countries. Rather than being focused on plants useful for agriculture, as is the FAO Undertaking, the CBD is directed at the preservation of all plants and other organisms sustaining the global eco-system. . The CBD recognized that many countries had already implemented intellectual property protection of technology involving biological material. On the other hand, the Convention eliminated the 'common heritage of mankind' status of wild plants and landraces. Instead, it was accepted that 'countries of origin' had sovereign rights over all biological material (plants, animals, microorganisms) originating in their national territory. The CBD gave plants the status of national property, providing a legal basis for 'benefit sharing' arguments. It is rather contradictory to give national governments such power over PGR in a world where free-market is the dominant discourse.

TRIPS agreement was a result of an initiative of the worlds' main industrial interest organizations to protect new technology, medicines and audiovisual works better against imitation. Legal protection of innovations related to biological material was initially not so relevant, but emerged as a negotiation topic around 1990, four years after the start of Uruguay Round, when firs genetic engineering products were in the market.. The large chemical and pharmaceutical companies that had become involved in genetic engineering and crop development began to realize that worldwide protection would soon become essential in order to defend their leading edge. A group of developing countries opposed plans to strengthen the international patent system. They advocated the exclusion from patentability of (among other things) plant or animal varieties and other products or processes if this was required in the grounds of public interest. Despite the opposition, the TRIPS agreement was signed by 125 countries in 1994 as part of the new GATT. This agreement implies that legal protection of crop plants is recognized in most parts of the world.

Another FAO International Treaty on PGR for Food and Agriculture will start to function on June 29th 2004. At least 40 countries have signed it. The treaty establishes a "Multilateral system" of food and agriculture genetic resources in order to facilitate access and benefits distribution. It includes 32 food crops and 29 forages. The facilitated access concerns only to research, improvement or teaching purposes and there is no recognition to IPR that limit access to components or genetic parts in the way they were received in the multilateral system. The document establishes as an obligation IPR benefits' distribution, as well as the product can be used for others for research and improvement purposes (www.biodiversidadla.org, 2004).

The treaty also recognizes farmers' rights to save, use, exchange and sell seeds and propagation materials. Mexico has already signed this treatment, which is important as transgenic pollution can generate demands from the owners of transgenic patents.

Conclusions

Concerning plant genetic resources, a country needs to have a good strategy for their exploitation. This strategy is part of an agriculture development long term policy. In countries like Mexico, with high genetic diversity, weak agriculture, a significant poor peasant population dedicated to produce basic food (beans and maize), agriculture genetic resources are not considered as valuable, there is a waste and neglect of them. Public research centers do not have funds to take care of them and private investment, the goal of neoliberal policies for agriculture´s growth, is not interested, with the exception of some big corporations dedicated to produce vegetables, some fruits and flowers, associated with profitable farmers.

Small farmers are not profitable, but they accomplish environmental functions concerning genetic resources conservation. According to recent policies they should not produce and go elsewhere, but Mexican economy does not generate employments for them. Since transgenic maize's pollution, specially in Oaxaca, where transgenes were first found, these producers are more concerned about their maize's quality and genetic resources preservation, maybe that is an alternative coming from civil society and not from government authorities nor industry.

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