Agri-food Sector Innovation System MEXICO

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Executive Summary

This study forms part of a project driven by the Inter-American Institute for Cooperation on Agriculture, which aims to develop a diagnostic methodology for national agri-food innovation systems. The pilot of this methodology has been applied in three countries: Bolivia, Costa Rica and Mexico. This document presents the Mexican case.

A diagnosis of the National Agri-Food Innovation System (SNIA) was carried out in Mexico through the consultation of a variety of published sources (laws, regulations, standards, programs, institutional reports, patents, specialized articles and websites) and consultation with national specialists (through direct interviews or as part of a specific workshop).

The main conclusions of this diagnosic have led to an admission that the SNIA is very fragmented since there is little interaction between the different players. Knowledge creators at research centers and universities are more motivated to produce academic results than to participate in effectively solving the sector's problems, which is primarily due to prevailing incentive systems. Technology, technical assistance and training transfer mechanisms have not worked properly since the professional services provider has diluted efforts in an excessive number of operational functions and deficiencies. Faced with this, producers and companies turn to other knowledge sources, primarily specialized supplies providers and equipment suppliers.

Lack of coordination is accompanied by another extremely significant restriction: the scarcity of resources for technology research, development and promotional activities. In practice, innovation does not receive priority treatment and this is manifested in the lack of resources dedicated to it.

Access to the benefits of innovation by producers and companies is extremely inconsistent and unequal since only the category of producers and companies dedicated to serving markets connected to a global value chain achieves effective integration with SNIA players by exploiting different types of state support, research capabilities and the intellectual property system. At the other end are producers, small companies and even regions of the country, which are at the margins of technical change and excluded from SNIA.

Faced with this situation, an institutional framework for innovation has been promoted with a variety of legal instruments, programs and specific funds for technological development, intellectual property protection, project finance, market

information, direct support to producers and some subsidies. This framework is in principle very complete, but gives rise to a system so complex that it becomes inefficient and ineffective.

Finally, it is concluded that the innovation policy in this sector requires an in-depth review to encourage its effective application and a much better social and regional distribution of its benefits.

INTRODUCTION

Organizations do not innovate in isolation and, in the final analysis, innovation does not solely involve production and the exchange of technological knowledge and information. There are additional factors which play a key role, such as policies and legislation, infrastructure, access to economic funds, availability of qualified human resources and market development,[1] to name but a few. Consequently, several players are identified as relevant in the innovation process: producers, entrepreneurs, researchers, consultants, politicians, suppliers, processors, vendors and clients, all of whom form interactions and connections to successfully align learning and negotiation processes, thereby giving form to innovation[2]. Therefore, the basic idea of an innovation system is that—as a derivation of the actual concept of innovation—it considers not only the typical Research and Development (R&D) or Science and Technology (S&T) players.

Taking into account the focus on the innovation system of the agri-food sector, the scope or dimension of its analysis are three-fold, according to that proposed in the methodology for the study on "sectoral systems:"

a) Production base, knowledge and technology base

b) System players and networks

c) Institutional character of the system

The first dimension—knowledge, technology and production base—start from the vision that the sector has a specific knowledge, technology and supply base, which defines its dynamic and limits. The purpose of this dimension, which constitutes Axis 1 of the **Methodology Guide for the Diagnosis of Agri-Food Innovation National Systems in Latin America and the Caribbean** (*Guide*)[3], is the delimitation and characterization of this specific base, thereby defining how it is organized and what are the most important sectoral indicators delimiting the system.

According to the *Guide*, the knowledge, technology and production base dimension is considered to be the characterization and analysis of the production situation of the

[1] Document translated by IICA Mexico office, with the authorization of the author Klerkx, L. Hall, A and Leeuwis, C. (2009).
"Strengthening agricultural innovation capacity: are innovation brokers the answer?" Int.J. Agricultural Resources, Governance and Ecology, Vol. 8, Nos.5/6,pp.409-438.
http://www.redinnovagro.in/documentosinnov/Enhancing_ag_innovation_capacity-brokers.pdf

[2] Malerba, F. Sectoral systems of innovation and production. Research Policy, Volume 31, Issue 2, February, 2002. pp. 247 – 264

[3] Innovation Program for Productivity and Competitivity (PIPC) of the Inter-American Institute for Cooperation on Agriculture (IICA)

food and agricultural system in Mexico with data on how it is organized and what are the main productive agri-food characteristics, products, producers and regions, as well as data relating to the S&T system.

The analysis is based on physical production, land productivity, production value, international sales profile, use of technologies and knowledge, R&D investment and other data and historical series, in accordance with the system of indicators proposed in the Guide.

Axis 1 – Characterization of the production base and TIS system in Mexico

This characterization shows **how agricultural and agri-food production has evolved in Mexico, along with its trends, what the diversity of the production systems is in terms of their innovation dynamic and what their strengths and weaknesses are, and what is the productive and technological density of the system in Mexico, among other things.**

The analysis period comprised 10 years for the majority of the indicators and its main information sources are the following databases (Table 1).

Table 1. Main sources of information for the characterization of the production base and TIS system of the agri-food sector in Mexico

SCIENTIFIC AND TECHNOLOGICAL INDICATORS	http://www.siicyt.gob.mx/siicyt/cms/paginas/IndCientifTec.jsp
2011 STATISTICAL YEARBOOK OF THE UNITED STATES OF MEXICO	http://www.inegi.gob.mx/prod_serv/contenidos/espanol/bvinegi/productos/integracion/pais/aeeum/2011/Aeeum11_1.pdf
TIMELY INDICATORS OF OCCUPATION AND EMPLOYMENT	http://www.inegi.org.mx/inegi/contenidos/espanol/prensa/comunicados/ocupbol.asp
Bank of Economic Information (BIE) INEGI	http://www.inegi.org.mx/sistemas/bie/
WORLD BANK	api.worldbank.org/datafiles/MEX_Country_MetaData_es_EXCEL.xls
Statistical Appendix Fifth Government Report 2011	http://biblioteca.itam.mx/recursos/infgob11.html#anexo_2
INEGI. AGRO statistics	http://www.inegi.org.mx/Sistemas/temasV2/Default.aspx?s=est&c=23824
The Food Sector in Mexico 2011 Sectoral Statistics Series	http://www.inegi.org.mx/prod_serv/contenidos/espanol/bvinegi/productos/integracion/sociodemografico/SAM/2011/sam2011.pdf
SAGARPA, ECONOMIC AGRI-FOOD ANALYSIS	http://www.sagarpa.gob.mx/agronegocios/Estudios/Paginas/estudios.aspx
SAGARPA, FOREIGN TRADE	http://www.sagarpa.gob.mx/agronegocios/comercio/Paginas/Comercio-Exterior.aspx
FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS FAO	http://faostat.fao.org/site/576/DesktopDefault.aspx?PageID=576#ancor
Ibero-American Network of Science and Technology Indicators (RICYT)	http://bd.ricyt.org/
OECD StatExtracts	http://stats.oecd.org/index.aspx
Plant Variety Rights Gazette	http://snics.sagarpa.gob.mx/dov/Documents/Gaceta_DOVdic2012.pdf

The set of 60 indicators of Axis 1 is grouped into three dimensions:

- Economic and socio-environmental dimension (19 total indicators; 6 synthetic indicators)
- Production dimension (15 indicators; 5 synthetic indicators)
- Science, technology and innovation dimension (26 indicators; 14 synthetic indicators)

CHAPTER 1. ECONOMIC AND SOCIO-ENVIRONMENTAL DIMENSION

The GDP of the agri-food sector is made up of primary sector activities (agriculture, livestock, fishing, forestry and hunting) and the agroindustry sector (food, drink and tobacco). According to the *Guide*, the focus on food and the food economy in its agricultural, industrial and commercial perspective, as proposed by Louis Malassis and his collaborators,[4] would serve as a reference for this work. Therefore, the wide-ranging concept of agri-food is "that which respects production and value creation in the primary and industrial production of food, as well as in the commercial and distribution and logistics links, which have an influence on the creation and appropriation of value, in other words, innovation in the phases of the process of production, processing and sale of agricultural foods (cattle raising, forestry and fishing)[5].

The Mexican agri-food system has been oriented at two main aspects: on the one hand, at supplying the food needs of the general population which, as well as the intrinsic benefits of the activity, generate a significant economic output; and on the other, at new product markets stemming from changes in consumption patterns. In recent years, the agri-food sector has found, in both internal and external markets, different niches which have encouraged part of the production to be allocated to serving this new demand. Therefore, the specialization of the offer to such markets, which have experienced significant growth in recent years, runs the gamut from specialized primary products to processed products with certain food characteristics demanded by consumers.

Mexico has a national territory of 198 million hectares, of which 145 million are dedicated to agricultural and livestock activity. Almost 30 million hectares are farmland and 115 million are pasture land. Furthermore, forests and jungles make up 45.5 million hectares[6].

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[4] Malassis (1973; 1979); Malassis and Padilla (1986) and Malassis and Ghersi (1996) are authors who emphasized, from a food perspective, something which was already being discussed in literature: the fact that agriculture should not been looked at in isolation, that is, only in primary production.

[5] At the workshop held in April, 2012 to prepare these studies, it was agreed to exclude the forestry branch in order to concentrate the analysis on food production.

[6] SAGARPA (Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food) 2007, Sectoral Program for Agricultural, Livestock and Fishing Development 2007-2012.

Agriculture in Mexico is more than an important production sector. Over and above its participation in the national GDP, which is barely an average of 4 per cent[7], the multiple functions of agriculture in economic, social and environmental development determine that its incidence in development is far greater that what that indicator would imply. The following can be mentioned as some of the arguments demonstrating the relevance of agriculture in the country:

1. Practically all food production originates in this sector (including fishing) so that the sectoral offer (internal and external) is fundamental in food safety, the cost of living and the real income of the population group, particularly of the poorest, which allocate a greater proportion of its income to the purchase of food. "The population of the poorest decile allocates over half (51.8 per cent) of current monetary expense to food, while in the richest decile, the proportion is only 22.7 per cent).[8]

2. Agricultural and livestock products form the basis of a large number of commercial and industrial activities. If we consider agroindustrial production, the contribution of this sector to Mexican GDP rises to over twice as much, at over 9 per cent. Moreover, unlike the primary agricultural product, "the contribution of agroindustry to economic growth does not tend to fall as economic development increases. In developed countries and even in some Latin American countries such as Argentina, Brazil, Chile and Uruguay, the contribution of agroindustry to GDP is as much as two or three times greater than that of primary production, in a process of increasing inter-sectoral articulation. The potential for growth of this participation is particularly extensive in Mexico."[9]

3. Agriculture provides employment to around 13 percent of the workforce, which represents some 3.3 million producers and 4.6 million salaried workers and non-paid family members. Of even greater relevance to territorial development is the fact that approximately **24 per cent of the total population lives in rural areas.**

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[7] INEGI (National Statistics and Geography Institute), 2009, Economic Climate Data

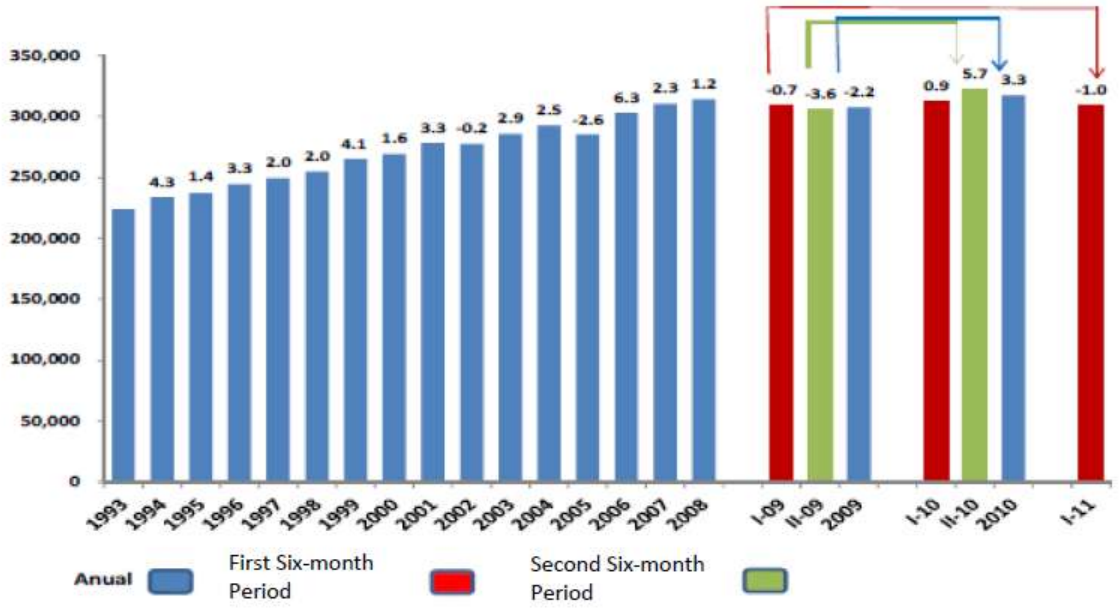
[8] INEGI, National Home Income and Expenditure Survey 2008 and Agriculture and Rural Development in Mexico http://coin.fao.org/cms/world/mexico/InformaccionSobreElPais/agricultura_y_des_rural.html. (Extract from "The FAO in Mexico: over 60 years of cooperation ").

[9] Agriculture and Rural Development in Mexico http://coin.fao.org/cms/world/mexico/InformaccionSobreElPais/agricultura_y_des_rural.html (Extract from "The FAO in Mexico: over 60 years of cooperation ").

4. “Agriculture has important backward and forward linkages with other sectors. Agriculture in Mexico is more and more modern (though distribution of the benefits of this modernity is inconsistent) and is more integrated with the rest of the economy in that more intermediate supplies are purchased and its products are sold as intermediate supplies in other sectors. Employment is important in these non-agricultural activities: the selection, packaging and refrigeration of fresh fruit and vegetables, as well as the treatment of forestry products. While less significant, there are also links in the initial stage: the production and distribution of agricultural supplies, machinery and equipment. Using an estimated figure of an “extended agricultural GDP increases the adjusted participation of agriculture from the aggregate total national value of 4 per cent to almost 8 per cent, perhaps a calculation that is too low.”[10]

5. In the period 1993-2010, the average annual growth rate of Primary GDP was 2.1 per cent, with variations primarily located in periods of escalating economic crises in the country (Figure 1).

Figure 1. Evolution of GDP in the primary sector



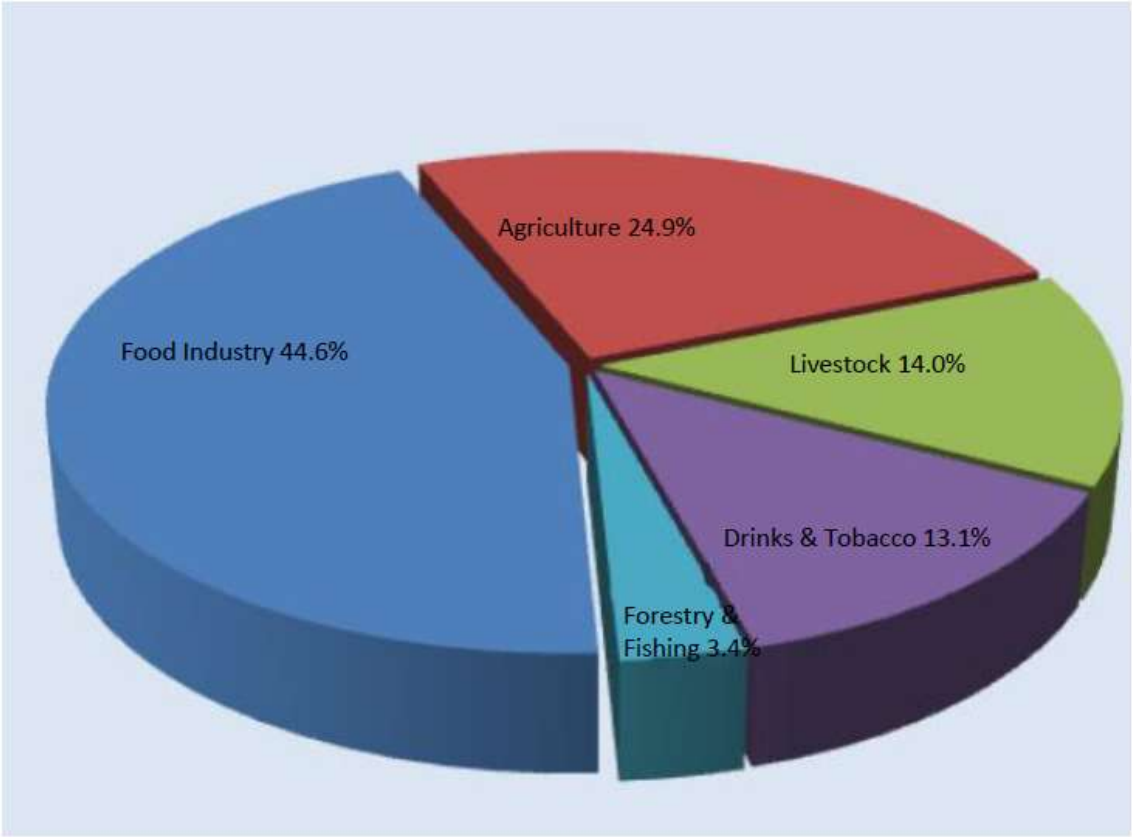
Source: Vice-Ministry for Promotion of Agribusiness (SFA) with data from INEGI.

[10] OECD (2011). Analysis of agricultural outreach in Mexico, Organization for Economic Cooperation and Development, Paris, p. 4

According to the System of National Accounts, agriculture, livestock, forestry and fishing related activities represented 4.11 per cent of total GDP in 1993. In 2000, this figure was 3.79 per cent. In previous periods, during and after the crisis,[11] said participation reached 3.75, 3.83 and 3.90 per cent respectively, which would first of all indicate that the effects were not as profound for this sector.

In regard to agri-food GDP, in 2009 it stood at 1.1 billion pesos and in the period 2005-2009, it recorded an average annual growth rate (AAGR) of 2.2 per cent in real terms. As can be seen in Figure 2, the greater economic contribution comes from the processed food industry, which accounts for the great importance of the agro-industry's participation in creating value within this sector.

Figure 2. Composition of agri-food sector GDP 2009 (percentages)



[11] Global slowdown due to the 2008-2009 economic crisis. The periods correspond to the last quarters of 2007, 2009 and 2010 respectively.

Source: INEGI

The greatest dynamism was recorded in agriculture and in the drinks and tobacco branches with an AAGR of 3.5 per cent and 3.1 per cent respectively. Livestock activity also showed a significant increase from 2.7 per cent in this period. In contrast, the less dynamic sectors were the food industry (1.4 per cent) and forestry and fishing. Primary activity (agriculture, livestock, forestry and fishing) represented 42.3 per cent of agri-food GDP while the food manufacturing sector (food, drinks and tobacco) participates with 57.74 per cent, which is consistent with that observed worldwide in recent decades due to changes in food consumption patterns, which have led to it rising in the value chain.

Table 2. Primary Sector Gross Domestic Product (million pesos at 2003 prices)

YEAR/ QUAR	NATIONAL TOTAL		AGRICULTURE		LIVESTOCK		FORESTRY, HUNTING & FISHING	
	GDP	VAR %	GDP	VAR %	GDP	VAR %	GDP	VAR %
1993	224,117		142,225		60,548		21,343	
1994	233,738	4.3	147,194	3.5	63,249	4.5	23,294	9.1
1995	236,947	1.4	149,301	1.4	66,066	4.5	21,579	-7.4
1996	244,721	3.3	155,867	4.4	64,844	-1.9	24,011	11.3
1997	249,557	2	157,221	0.9	68,650	5.9	23,686	-1.4
1998	254,615	2	157,151	0	73,246	6.7	24,218	2.2
1999	265,025	4.1	162,128	3.2	77,981	6.5	24,916	2.9
2000	269,225	1.6	160,503	-1	81,600	4.6	27,123	8.9
2001	278,237	3.3	167,884	4.6	85,608	4.9	24,745	-8.8
2002	277,592	-0.2	166,438	-0.9	87,661	2.4	23,493	-5.1
2003	**285,751.5**	**2.9**	**170,935.8**	**2.7**	**89,440.8**	**2.0**	**25,375.3**	**8.0**
I	268,302.0	1.2	162,942.0	-0.6	82,611.0	3.5	22,749.0	6.5
II	290,165.0	3.1	178,999.0	3.4	86,812.0	2.6	24,355.0	2.6
III	269,379.0	3.1	151,614.0	3.9	93,113.0	0.3	24,652.0	9.8
IV	315,160.0	4.2	190,188.0	4.1	95,227.0	2.0	29,745.0	12.6
2004	**292,805.8**	**2.5**	**173,898.5**	**1.7**	**93,027.3**	**4.0**	**25,880.0**	**2.0**
I	287,350.0	7.1	177,649.0	9.0	86,824.0	5.1	22,877.0	0.6
II	299,113.0	3.1	184,423.0	3.0	89,733.0	3.4	24,957.0	2.5
III	264,575.0	-1.8	143,640.0	-5.3	95,264.0	2.3	25,671.0	4.1
IV	320,185.0	1.6	189,882.0	-0.2	100,288.0	5.3	30,015.0	0.9
2005	**285,239.5**	**-2.6**	**164,457.8**	**-5.4**	**94,955.8**	**2.1**	**25,825.8**	**-0.2**
I	280,783.0	-2.3	168,396.0	-5.2	88,907.0	2.4	23,479.0	2.6
II	287,385.0	-3.9	169,593.0	-8.0	92,954.0	3.6	24,839.0	-0.5
III	271,803.0	2.7	150,152.0	4.5	96,333.0	1.1	25,317.0	-1.4
IV	300,987.0	-6.0	169,690.0	-10.6	101,629.0	1.3	29,668.0	-1.2
2006	**303,305.3**	**6.3**	**178,878.3**	**8.8**	**98,116.5**	**3.3**	**26,310.8**	**1.9**
I	288,866.0	2.9	173,991.0	3.3	91,598.0	3.0	23,276.0	-0.9
II	315,211.0	9.7	195,506.0	15.3	94,522.0	1.7	25,184.0	1.4
III	271,561.0	-0.1	146,849.0	-2.2	99,326.0	3.1	25,386.0	0.3
IV	337,583.0	12.2	199,167.0	17.4	107,020.0	5.3	31,397.0	5.8
2007	**310,550.0**	**2.4**	**181,566.0**	**1.5**	**101,662.0**	**3.6**	**27,321.8**	**3.8**
I	293,196.0	1.5	173,326.0	-0.4	94,186.0	2.8	25,684.0	10.3
II	326,289.0	3.5	200,889.0	2.8	98,650.0	4.4	26,749.0	6.2
III	281,964.0	3.8	153,528.0	4.5	103,810.0	4.5	24,626.0	-3.0
IV	340,751.0	0.9	198,521.0	-0.3	110,002.0	2.8	32,228.0	2.6
2008	**314,300.8**	**1.2**	**183,729.3**	**1.2**	**104,191.8**	**2.5**	**26,379.8**	**-3.4**
I	286,701.0	-2.2	166,238.0	-4.1	95,317.0	1.2	25,146.0	-2.1
II	337,370.0	3.4	209,975.0	4.5	101,686.0	3.1	25,709.0	-3.9
III	283,681.0	0.6	153,546.0	0.0	106,656.0	2.7	23,479.0	-4.7
IV	349,451.0	2.6	205,158.0	3.3	113,108.0	2.8	31,185.0	-3.2
2009 p/	**320,040.8**	**1.8**	**188,569.8**	**2.6**	**105,765.5**	**1.5**	**25,705.3**	**-2.6**
I	287,096.0	0.1	164,081.0	-1.3	97,263.0	2.0	25,752.0	2.4
II	348,802.0	3.4	221,507.0	5.5	102,300.0	0.6	24,995.0	-2.8
III	287,349.0	1.3	155,368.0	1.2	108,627.0	1.8	23,354.0	-0.5
IV	356,916.0	2.1	213,323.0	4.0	114,872.0	1.6	28,720.0	-7.9
2010	317,540	3.3	180,286	4	109,733	2.1	27,520	3.7
2011/t3	303,702	-0.1	169,321	-1.9	109,043	2.9	25,338	-0.1

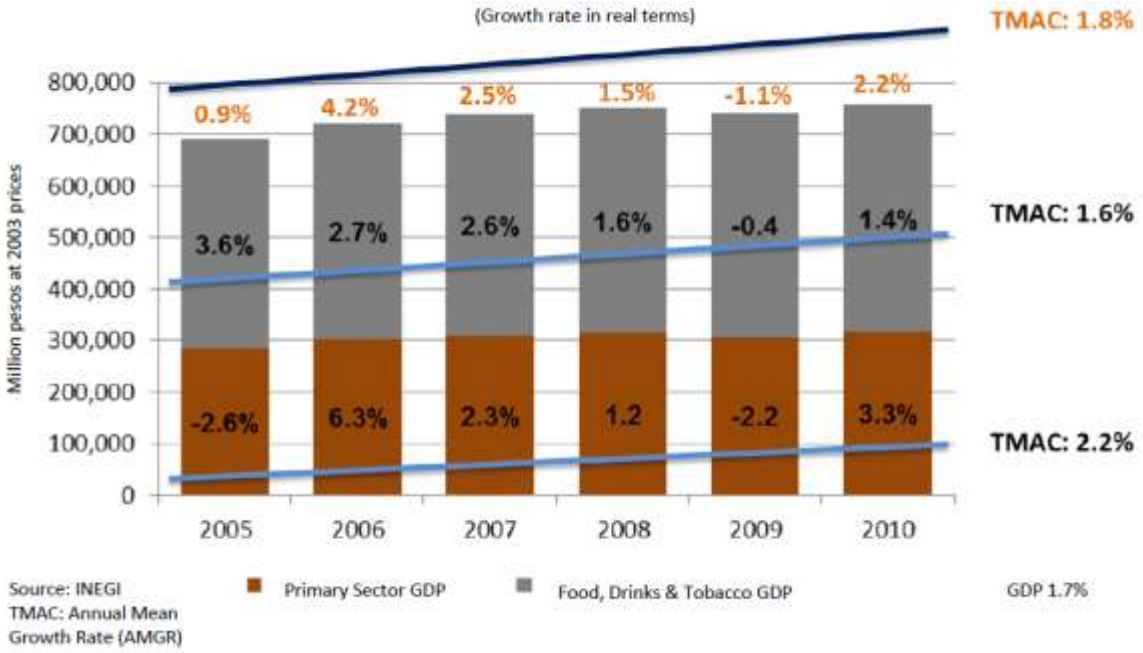
Source: Prepared in-house with data from the Agri-Food and Fishing Information Service, SAGARPA and with information from INEGI. System of National Accounts of Mexico.[12]

12 http://www.campomexicano.gob.mx/portal_siap/Integracion/EstadisticaDerivada/IndicadoresEconomicos/IndMacroeconomicos/prointbto.pdf

As Table 2 shows, in the period 1993-2010, primary GDP grew at an AAGR of 2.1 per cent while agriculture grew at 1.4 per cent, livestock at 3.6 per cent and fishing at 1.5 per cent, which clearly shows the performance differentials between the main branches making up the agricultural livestock sector.

During the period 2006-2010, the average annual growth of the total Gross Domestic Product (GDP) was 1.8 per cent. In the same period, primary GDP recorded an average rate of 2.2 per cent, secondary GDP 1.2 per cent and tertiary GDP grew to an annual average of 2.4 per cent. In 2010, total GDP presented a significant growth of 5.4 per cent from 2009, though to a lesser extent, primary GDP also grew by 3.3 per cent that year (Figure 3).

Figure 3. Agri-food sector GDP, 2005-2010



Unlike industrial GDP, the economic activity of the primary sector has demonstrated a growing historical trend (though with much more pronounced fluctuations) deriving from a variety of factors, including the increase in international grain and oilseed prices, the exploitation of specific export markets which were previously limited and the increased yield of some products.

As Table 2 shows, sector growth, while sustained, is low.

For 2011, the value of agri-food, agriculture and livestock and fishing production was barely 14.3 per cent more than that recorded in 2003 in real terms, that is to say, 758,299 million pesos in 2003 against 663,254 million pesos. This accounts for the loss of real value in the sector and supports the hypothesis that for it to rally it needs to be given greater priority.

The most recent figures on the primary sector of the economy show that it grew 9.5 per cent during the second quarter in 2012, thereby achieving four quarters of constant growth. Overall, the GDP of said sector increased 4.1 per cent in real terms in relation to the same period of the previous year.

As for the food industry, it grew 1.9 per cent, thereby achieving nine quarters of continuous growth. The agri-food sector GDP—primary plus food, drinks and tobacco—recorded an increase of 5% in relation to the same quarter in the previous year as a consequence of significant growth in the agricultural subsector of 16.1 per cent and an increase in the livestock subsector of 0.7 per cent during this period.

It is important to say that population levels with higher income have created a growing demand for food with higher added value, such as meat, dairy, pasta, frozen vegetables and ready-made foods, among others.

"This has created an opportunity for the agri-food industry to specialize in niches as a development strategy, such as the competitive production of higher volumes of processed food and drinks with certain characteristics demanded by the market and with higher added value for the internal market to sell locally and for export.
New demand characteristics have also had an impact on foreign trade in the sector; both imports and exports include an ever greater quantity and variety of high value products aimed at specific consumption niches." [13]

The sale of agri-food production is the final link in the chain and represents a significant proportion of trade. Trade in this economic activity comprises the wholesale sale of groceries, food, drinks and tobacco.

As the figures presented show, agri-food GDP is less vulnerable to crises and recovers better than total GDP, though it still has a subordinate role in regard to the development of manufacturing and service sectors.

In regard to fishing, according to the document "Diagnosic and Regional Planning of

[13] SAGARPA (2010). Challenges and opportunities of the agri-food system in Mexico in the next 20 years, Ministry of Agriculture, Livestock, Fishing and Food, México, D.F.

Fishing and Aquaculture in Mexico,"[14] fisheries operate on the basis of the availability of a resource and the number and magnitude of these depend on the quantity, productivity and maturity of existing ecosystems. In this sense, Mexico is a privileged country since it has an extensive coast spread out over five water bodies (North Pacific, Gulf of California, Tropical Pacific, Gulf of Mexico and the Caribbean) and their exclusive economic zone comprises almost three million square kilometers. The number of exploitable marine resources is very high: around 1,000 or more if we consider the different species included under the same generic names. Nevertheless, few of them have real significance whether for their magnitude or for their value. Furthermore, a clear asymmetry appears in the distribution of important resources (e.g. sardine, abalone, lobster) as a reflection of the timely availability of areas high in biological enrichment primarily towards the northeast of the country. There is also asymmetry in regard to the baltimetric distribution of resources since the majority is concentrated on the coastal strip. These irregularities are emphasized more if we consider the value of each of the resources. Therefore, **the relevance of fishing activity in the national arena results in a rather unequal map between the regions,** which goes from areas with a concentration of subsistence fishing to those where an industrial export activity is being developed.

In regard to aquaculture, CONAPESCA[15] (National Commission for Aquaculture and Fishing) acknowledges that "Despite the fact that aquaculture in Mexico has had a long trajectory, this activity has not yet positioned itself as an important economic sector. In 2004, the contribution of Mexican aquaculture to GDP was only 0.047 per cent (calculated from World Bank figures) and its contribution in 1984 was 0.006 per cent. Mexico occupied 10th place in 2004 in regard to its GDP and only 28th place for its aquatic production. The population that year was approximately 103 million and total *per capita* consumption of fish and seafood was around 12.9 kg (direct human consumption; 10.2 kg; indirect human consumption: 2.7 kg). If we compare these figures with those of 1994, we can see that demand for aquatic products increased in Mexico. From the population growth trends, it is estimated that in 2030, the Mexican population will reach almost 121 million and if aquatic production maintains the same growth trends, it is very likely that *per capita* consumption of fish and seafood will fall. This theory is also based on the fact that the extraction of aquatic products by fisheries seems to have reached a stable level, which will not allow growing demand for fish and seafood to be met."

CONAPESCA's diagnosis means that some problems have been detected which do

[14] CONAPESCA (2008). Diagnosic and Regional Planning of Fishing and Aquaculture in Mexico, Ministry of Agriculture, Livestock, Fishing and Food, Mexico, D.F. p. 3-4
[15] CONAPESCA (2008), op. cit. p. 45

not allow the aquatic sector to develop as an efficient production line. On the one hand, aquatic production is associated with structural deficiencies, organizational limitations and insufficient technology and training. On the other, current aquaculture planning does not contain any elements that ensure sustainability. This is due to the fact that it does not include economic, social and environmental development aspects that are sufficiently connected to technological, institutional, legal and regulatory development aspects

Despite these limitations, the actual diagnosic acknowledges that Mexico has great potential to increase its aquatic activity due to its extensive coastline, internal waters, diverse climate conditions and natural resources. Therefore, most state governments have included this activity in their government agendas and development plans. Likewise, CONAPESCA has declared that the cultivation of aquatic species is a priority for the federal government, which is why it has allocated financial support to the production sector. For 2030, the goal is for the country to reach an aquatic production of one million tons. In the first stage, production growth will probably be slow. Nevertheless, in the second stage, as cultivation technologies dominate, production will enjoy rapid growth. One million tons is the average volume currently being reached by the top ten producer countries (without taking China into account)[16].

Employment in the agri-food sector

For the purpose of comparison, during the period 2005-2010, the economically active population (EAP) fell by an annual average of 1.5 per cent, which means that the national EAP in 2010 was calculated at 43.1 million, while in 2005 it was 47.1 million. The urban EAP won ground from the rural EAP. The rural EAP in 2005 and 2010 registered 8.9 million, while the urban EAP in 2005 was 34.2 million and in 2010 was 38.3 million.

[16] CONAPESCA (2008) op. cit. p.46

Table 3. Evolution of gainfully occupied population and distribution according to activity sector in Mexico, 1995-2010

Year	Total Gainfully Occupied	Primary	Secondary	Tertiary
1995	32,652,186	23.7	23.1	53.0
1996	33,968,601	22.1	24.1	53.7
1997	35,924,799	23.7	23.9	52.4
1998	36,871,693	19.5	26.5	54.0
1999	37,279,863	20.5	27.1	52.4
2000	38,044,501	17.6	28.4	54.0
2001	38,065,752	17.5	27.6	54.9
2002	38,939,664	17.3	26.7	56.0
2003	39,221,542	16.2	26.6	57.2
2004	40,561,014	15.8	26.5	57.7
2005	40,791,814	14.9	25.5	59.0
2006	42,197,775	14.3	25.6	59.4
2007	42,906,656	13.5	25.7	60.1
2008	43,866,696	13.1	25.5	60.6
2009	43,344,281	13.0	24.0	62.2
2010	44,651,832	13.2	23.7	62.4

During the last ten years, employment in the agricultural and livestock sector recorded a constant contraction. In 2000, persons gainfully occupied in primary activities represented 17.9 per cent of the entire national occupation. In 2003, 2006 and 2008, this downward trend continued, recording levels of 16.2, 14.3 and 13.1 per cent respectively.

However, in the period 2008-2010, no significant reduction in this participation was registered. At the close of 2010, agricultural and livestock employment was at the same level as at the start of the crisis, nevertheless, this implies two years of decline in the primary labor market since it is true that a large number of jobs have not been lost, but nor has there been any net creation.

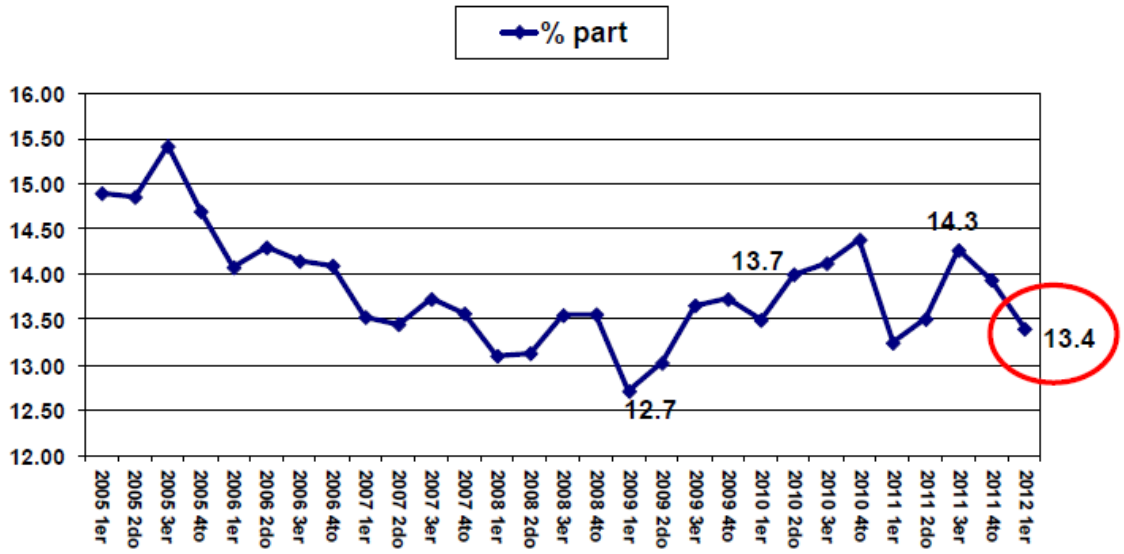
Source: based on INEGI, ENE (National Employment Survey) and ENOE (National Occupation and Employment Survey on) data[17]

[17] Nelson Florez Vaquiro (2011) MEXICAN WORK AND AGRICULTURAL PRODUCTION STRUCTURE FROM THE LATE TWENTIETH CENTURY TO THE EARLY TWENTY-FIRST CENTURY. FLACSO MÉXICO http://www.flacso.edu.mx/micrositios/informa/images/pdf/trabajo_sector_agropecuario_florez.pdf

In regard to occupation, the labor market has demonstrated an inability to absorb the workforce. Within the activities related to the agricultural and livestock field, the employment level enjoyed an annual average growth rate of 1.84 per cent during the period 2000-2006, while in 2008-2009 this figure barely reached 0.48 per cent and fell by 1.63 per cent in the last two years due to the crisis. Against this background, it is not surprising that rural development policy places the emphasis on creating rural occupation opportunities outside of the sector.

If we compare employment evolution in the agricultural and livestock field with employment in the other economic activities (Table 3), we can see that gainful occupation in the primary sector is less and less with regard to the other sectors since the crisis has meant that the employment level in other sectors has fallen to 1.43 per cent. Figure 4 shows employment behavior in the primary sector in the last seven years.

Figure 4. Percentage share of the gainfully occupied population of the primary sector in the national total (up to the first quarter of 2012)



Source: BIE (Economic Information Bank), INEGI, ENOE.

In regard to the composition of employment in the agricultural and livestock sector, Table 4 shows that the greatest number is represented by independent workers (self-employed), but such a large number of unpaid workers who work in agriculture as a sussistence or complementary activity cannot be disregarded.

Table 4. Gainfully occupied population in the agricutlural and livestock sector, according to position in occupation (thousand)

Concept	2005	2006	2007	2008	2009	2010	TMAC* 2005-2010
Gainfully occupied population	6,390	6,029	5,894	5,909	5,990	5,903	-1.3%
Self-employed workers	2,695	2,452	2,432	2,363	2,395	2,315	-2.5%
Subordinate and paid workers	2,027	2,016	1,942	2,048	2,098	2,101	-0.6%
Unpaid workers	1,393	1,275	1,246	1,215	1,257	1,188	-2.6%
Employers	275	285	273	282	239	299	1.4%

***/ Average annual growth rate.**
SOURCE: SAGARPA (Ministry of Agriculture, Livestock, Rural Development, Fishing and Food) with data from the Agricultural and Livestock and Fishing Information Service

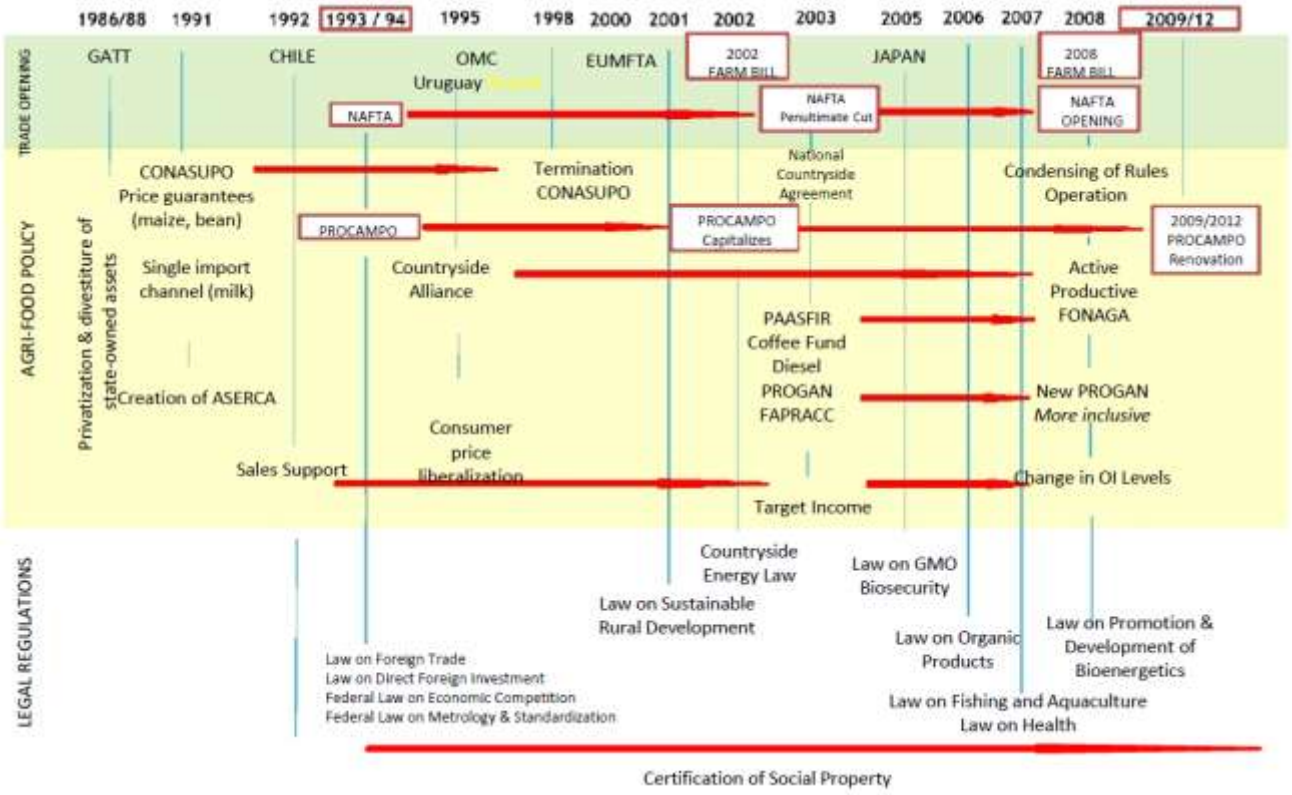
Sector foreign trade

In recent years, as a result of the policy to open the country's trading activities, foreign agri-food trade has continued to rise for both exports and imports, despite a slight fall in both areas in 2009 as a consequence of national and international economic slowdown.

The policy of financial support to the sector had to be adapted according to how the country participated in the global economy. Figure 5 clearly illustrates how the opening up of trade and especially NAFTA have been factors that have encouraged changes to financial support policies for the countryside, moving from financial support for guarantee price based trade and the participation of CONASUPO (National Company for Public Subsistence) as the body charged with stimulating production through the purchasing power of the State and selling basic subsidized products for the poor to direct financial support systems focused first and foremost on mitigating the effects of the paradigm shift on small producers.

There was also a sensitive change to the systems for outreach activities and comprehensive technical assistance for producers, moving from a public scheme to one based on service providers, as analyzed further on in this paper. This shift is primarily due to the fact that attempts have been made to promote an agriculture focused on agri-business and producers having a better understanding of the factors influencing sector competitivity. The Law on Sustainable Rural Development became in 2001 the governing instrument of the policy which, as Axis 3 of this study analyzes, includes the planning and organization of agricultural and livestock production, its industrialization and commercialization and of the other assets and services and all those actions to improve the quality of life of the rural population.

Figure 5. Policy on financial support to the sector starting from the international context



Source: AGRI-FOOD SECTOR PERFORMANCE INDICATORS (Feb 2011)[18]

[18] Working Group on Food Poverty, National Commission for Social Development http://www.nl.gob.mx/pics/pages/sdsocial_gtpobreza_base/PresGAAtallerSenado.pdf

Greater participation of agroindustrial activity has also led to greater participation in foreign trade, therefore, for both exports and imports, agroindustrial trade exchange exceeds that of the primary sector in value and it looks like this trend will continue in the future.

Thanks to joint agricultural and agroindustrial activity, agricultural and livestock and agroindustrial activity in Mexico rose to US$40,000 million in 2010, a figure four times higher than that recorded in 1993. This clearly shows that the behavior of the product market of the sector is much more dynamic than production.

Table 5. Agricultural and livestock and agri-food balance of trade (in million US$)

Year	Balance			Exports			Imports		
	Total	Agriculture and Livestock	Agri-food	Total	Agriculture and Livestock	Agri-food	Total	Agriculture and Livestock	Agri-food
1993	**- 1,757**	155	- 1,912	**3,955**	2,814	1,141	**5,712**	2,659	3,054
1994	**- 2,636**	- 359	- 2,277	**4,439**	3,059	1,381	**7,075**	3,417	3,658
1995	**1 326**	1 941	- 614	**6 406**	4 573	1 833	**5 079**	2 632	2 447
1996	**- 1,101**	- 480	- 620	**6 425**	4 122	2 303	**7 525**	4 602	2 923
1997	**- 366**	302	- 668	**7 075**	4 436	2 639	**7 441**	4 135	3 307
1998	**- 1,116**	- 409	- 707	**7 279**	4 320	2 959	**8 395**	4 729	3 666
1999	**- 837**	- 61	- 775	**7 536**	4 438	3 099	**8 373**	4 499	3 874
2000	**- 1 291**	- 128	- 1 163	**8 266**	4 752	3 513	**9 557**	4 881	4 676
2001	**- 2 753**	- 881	- 1 872	**8 119**	4 435	3 684	**10 872**	5 316	5 556
2002	**- 3 035**	- 1 189	- 1 847	**8 247**	4 196	4 051	**11 282**	5 385	5 898
2003	**- 3 085**	- 783	- 2 301	**9 217**	5 023	4 195	**12 302**	5 806	6 496
2004	**- 3 252**	- 712	- 2 540	**10 380**	5 666	4 713	**13 632**	6 378	7 254
2005	**- 2 742**	- 260	- 2 482	**11 732**	5 981	5 751	**14 474**	6 241	8 233
2006	**- 2 476**	- 387	- 2 089	**13 707**	6 836	6 871	**16 183**	7 223	8 960
2007	**- 4 738**	- 1 579	- 3 159	**14 791**	7 415	7 376	**19 529**	8 994	10 535
2008	**- 7 000**	- 3 943	- 3 058	**16 362**	7 895	8 467	**23 362**	11 838	11 525
2009	**- 2 422**	- 884	- 1 538	**16 072**	7 726	8 346	**18 495**	8 610	9 885
2010	**- 2 914**	- 1 235	- 1 679	**18 163**	8 610	9 552	**21 076**	9 845	11 231
*2011	**- 1 212**	- 829	- 384	**13 605**	6 599	7 006	**14 818**	7 428	7 390

Source: Working Group on Foreign Trade Statistics made up of the Banco de México (Bank of Mexico), INEGI, Tax Administration Service and Ministry of Economy.

It is important to be clear about the composition of agri-food foreign trade since, as Table 5 illustrates, a debit balance in the balance of trade has persisted in the last twenty years both for agricultural and agroindustrial products.

This highlights Mexico's dependence in regard to imports of agricultural and livestock supplies by food companies as a reflection of the critical situation of Mexico's

agricultural and livestock sector, but also that companies have not made sufficient efforts to develop suppliers.[19] According to Solleiro, the simplest option for important food agroindustries to have a reliable provision of supplies, which is also favored by the foreign exchange policy, has been to import. Such supply is an essential factor for food industry competitivity, which demands greater **quality and uniformity** in agricultural and livestock supplies, as well as compliance with sanitary standards, trade regulations and precise delivery times. This trade framework demands the incorporation and assimilation of technology and business skills which greatly surpass the traditional operating methods of an important segment of Mexican producers. This leads to a separation between the primary sector and the processing industry and causes such important sector value chains such as maize, soy, wheat and dairy to break down.[20]

This short-term vision on the part of the processing side of agroindustry brings uncertainty in the long term and a breakdown in the agroindustrial producer chain, which has a negative socio-economic impact, such as decapitalization of the countryside, rural migration, unemployment, marginalization, a trade deficit and an internal shortage of supplies. The result is the balance of trade deficit, which has maintained its negative trend.

If we observe the composition of imports and exports, we can also conclude that Mexico has a high and growing dependency in regard to basic foodstuffs (Table 5). On the other hand, its exports are related to horticultural products, pork and drinks such as beer and tequila.

Another feature of Mexican agri-food foreign trade is that it concentrates on the United States and on certain products: the rhythm of its import and export growth is imposed by the US market. According to Mella and Mercado, the narrow product range is a reflection of a marked specialization with a predominance of inter-industrial flows.[21]

[19] Solleiro, J.L. and Del Valle, M.C. (coords.) (2003). **"Competitive Strategies of the Food Industry**", Plaza y Valdés, México.
[20] Solleiro J.L. and Del valle (2003) op. Cit.
[21] Mella , J. and Mercado, A. (2006), The Mexican Agricultural and Livestock Economy and NAFTA, *Foreign Trade* 56 No. 3, March, 2006, 181-193

Table 6. Agri-food imports comparison 2011-2012

Concept	2011 JAN-MAR	2012 JAN-MAR	2012-2011 Variation Absolute	Relative
Agri-food imports	**5,658**	**6,617**	**959**	**% 16.95**
Yellow maize	441.0	856.1	415	94.11
Soy bean (Jan 1 to Sep 30)	385.3	405.9	21	5.35
Common wheat	226.1	295.0	69	30.43
Fresh or refrigerated beef (Boned)	220.1	210.9	-9	-4.16
Powdered milk or milk in tablet form	130.6	188.6	58	44.35
White maize (flour)	28.7	175.8	147	511.71
Rapeseed	197.5	173.4	-24	-12.20
Legs, shoulder and their pieces unboned, fresh or refrigerated	147.0	163.7	17	11.34
??? uncarded and uncombed cotton	219.5	144.4	-75	-34.22
Fructose (dry content over 50 per cent and under 60 per cent)	111.2	140.5	29	26.37
Soy paste	97.8	124.0	26	26.81
Other food preparations	109.1	114.2	5	4.64
Other products from common wheat	53.0	105.8	53	99.64
Soluble waste and grains dried from maize distillation	114.9	104.6	-10	-8.97
Unrefined Palm oil	88.5	103.0	15	16.41
Cow, sheep and goat fat	119.5	98.3	-21	-17.75
Other products from sugar	45.8	84.2	38	83.93
Apples	62.1	75.3	13	21.30
Others	2,860.4	3,053.5	193	6.75

Source: Economy, Global Trade Atlas
Note: Excludes Fishing Sector

A case worthy of analysis is that of the export of products for more sophisticated market niches since these have been growing. The example of organic products is particularly interesting (Table 7). More recent statistics are not available, but according to Schwentesius, in 2006 there were 590,000 hectares with 150,000 producers in Mexico, occupying first place globally for the number of producers, as well as being the leading producer of organic coffee.[22]

[22] Schwentesius Rita and Manuel Á. Gómez Cruz. Organic Mexico. CIESTAAM (Center for Social and Technological Economic Research for Agroindustry and Global Agriculture). Chapingo, Mexico. September, 2007. p. 26

This agricultural and livestock subsector has achieved growth rates of over 30 per cent. There is no other agricultural and livestock subsector as successful: according to the Ministry of Agriculture, it generates US$430 million in foreign exchange revenue.

From February 7, 2006 the Law on Organic Products came into effect, which defines organic production as "a system of production and processing of food, animal and vegetable products and subproducts and other satisfiers with the regulated use of external supplies and which restricts and, where applicable, prohibits the use of chemically synthetic products." However, the law's regulation was only published in 2012. Despite the success, the slowness in creating a regulation has been a limiting factor. According to a recently published survey, "it is important to develop a Mexican Organic Seal, successfully integrate Mexico as a tertiary country producer of organic or ecological food into the European Union, reduce certification costs, support scientific experimentation and general research, agroecological and technological training, as well as the link between universities, government and business owners. The aim of all this is to diversify export destinations, create greater added value for organic products, ecological marketing, etc., as well as to promote a national food culture that is healthy and supports local organic production processes."[23]

Table 7. Economic importance of organic agriculture in Mexico

	1996	1998	2000	2004/2005	AMGR (%)
Land area (ha)	23,265	54,457	102,802	307,692	33
Number of producers	13,176	27,914	33,587	83,174	23
Employment (thousand working day)	3,722	8,713	16,448	40,747	31
Foreign currency generated (US$1,000)	34,293	72,000	139,404	270,503	26

Source: Manuel Ángel Gómez Cruz, Rita Schwentesius Rindermann, Ma. del Refugio Meraz Alvarado, Aurora J. Lobato García, Laura Gómez Tovar (2005). "Organic Agriculture, Beekeeping and Cattle Raising in Mexico 2005. Challenges – Trends Situation, Autonomous University of Chapingo, Mexico, p. 13

The number of collective brands to sell regional products has also grown, but there

[23] Martínez Salazar, Gerardo M.; Oaxaca Torres, Jesús; Guerra Martínez, Rodrigo (2011), ORGANIC PRODUCTS; SUCCESSFUL AGROBUSINESS IN MEXICO, Mexican Agrobusiness Magazine, Vol. XV, Edition. 28, January-June, 2011, pp.. 503-513

is no specific organization to support their sale and standardize production. This clearly shows that it is necessary for export projects to be better accompanied by more effective and suitable policies and instruments.

The environmental issue

According to data from the Ministry of the Environment and Natural Resources (Semarnat), 64 per cent of Mexican land presents some kind and level of degradation. Only 23 per cent of land, with no apparent degradation, can sustain productive activities.[24] As for water resources, in 2001 the Water Quality Index of the National Water Commission (CNA) already showed that 74 per cent of water bodies showed some degree of contamination. Toxic contamination was found in 1 per cent and only in 26 per cent was the quality of the water acceptable.

According to SAGARPA, the diversity of land in Mexico creates and supports a great biodiversity. Unfortunately, 64 per cent of land presents a varying degree of deterioration and only 36 per cent does not present any apparent degradation and maintains sustainable production activities.[25] These figures account for the urgency for a more sustainable focus for production in the sector and the introduction of a more effective institutional framework, which enables the problems of pollution damaging the sector to be overcome.

Summary of the economic and socio-environmental situation in the sector

Among the different characteristics of the Mexican agri-food economy, the following stand out:

Its participation in the Mexican economy is small and falling, though its social importance is very great due to the number of jobs involved and the fact that 24 per cent of the population is concentrated in this sector.

Its production is not aimed as much at foreign markets as the rest of the economy since only a reduced number of products aimed at specialized niches is exported.

There are competitivity issues with foreign markets in terms of subsidies and other sources of cost containment, which has caused a growing dependence on imported supplies for key agroindustries such as maize, soy, wheat and dairy.

[24] www.semarnat.gob.mx.InfSitCap3suelos.pdf

[25] SAGARPA, "The land and agricultural and livestock production", 2007-2012 SAGARPA Sectoral Program, México, D.F.

A structural dualism persists in which a modern and export production system coexists alongside the traditional system which supplies the local market and the subsistence agriculture system with serious productivity and marginalization problems.

Foreign trade is specialized and concentrated in the United States.

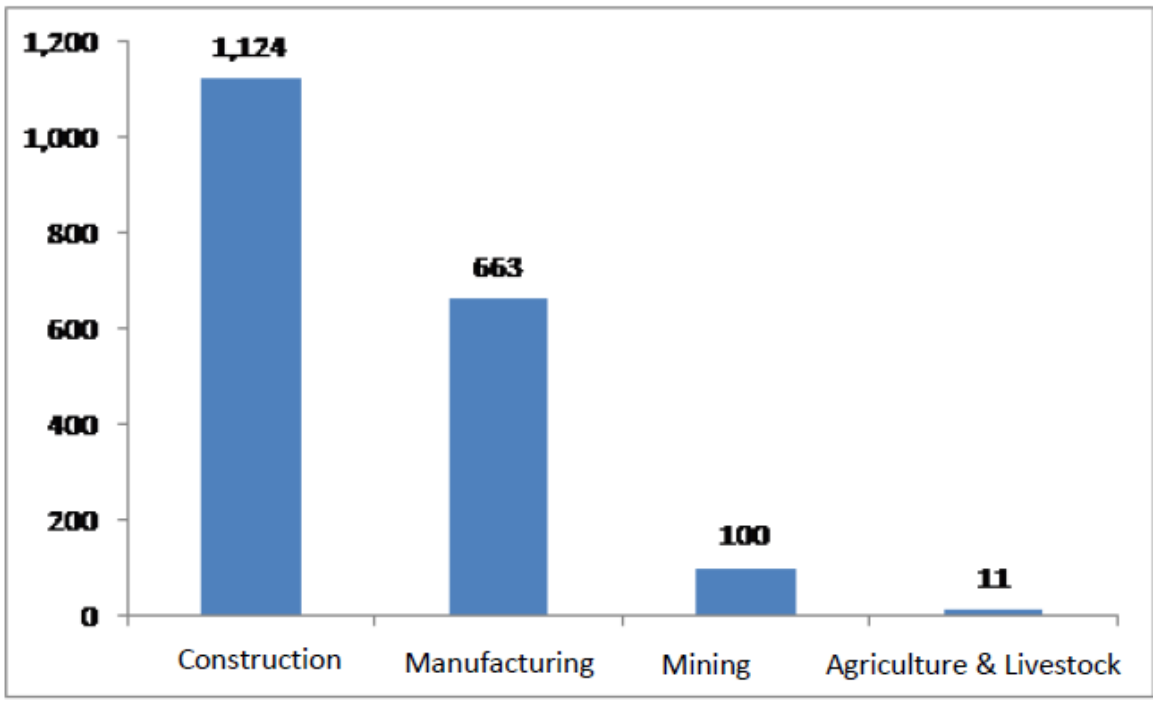
Serious environmental problems persist with growing contamination of land and water closely linked to agricultural and livestock activities.

CHAPTER 2. PRODUCTION DIMENSION

Investment and Direct Foreign Investment in the sector

The agricultural and livestock sector has had a subordinate role in regard to investment. The *per capita* investment figure (in US$) for 2010 (Figure 6), according to the Center for Private Sector Economic Studies (CEESP), speaks volumes.[26] At just US$11, this investment really deserves to be reviewed, that is, if the objective is to give agriculture a strategic role.

Figure 6. *Per capita* investment 2010



Source: CEESP (2012). Characterization of the global economic situation and the consequences for the agri-food sector, Center for Private Sector Economic Studies, México, D.F.

The expanded agri-food sector has managed to attract investment, though its presence in this area is small (just 3.89 per cent of total direct foreign investment acquired between 2000 and 2012) and the agroindustry has much greater real value, proving that investors are much more interested in activities with greater added value. The agricultural and livestock branch only attracted US$718.6 million in this period, therefore, it cannot be assumed that foreign investment can become an important

[26] CEESP (2012), Characterization of the global economic situation and the consequences for the agri-food sector, Center for Private Sector Economic Studies, México, D.F.

source of capitalization for the sector (Table 8). **Investment will definitely have to come from within.**

Table 8. Participation of direct foreign investment in the agri-food sector (2011-2012 comparison, in US$ million) 1/

Sector	Accum 2000-2012/2	Year 2011	% Part. Total 2011	Year 2012 1st Quarter	% Part. Total 2012
Agri-food	30,350.50	2,954.40	15.11%	170.10	3.89%
Agriculture & Livestock	718.60	22.30	0.11%	17.10	0.39%
Agroindustrial	29,631.90	2,932.10	14.99%	153.00	3.50%
Total	279,314.20	19,554.40	100%	4,372.40	100%

1/ Of the total accumulated in 2000-2012, 49.9 per cent comes from the United States, 15.3 per cent from Spain, 14 per cent from the Netherlands, 4.1 per cent from Canada, 3.1 per cent from the United Kingdom, 2.7 per cent from Switzerland and 1.8 per cent from Germany.
2/ From January 1, 2000 to March 31, 2012.
Source: Ministry of Economy

Profit and Profit distribution in the sector

Agriculture is a fundamental activity in rural areas, where a significant proportion of Mexico's population still lives. Twenty-four million Mexicans live in small scattered rural localities (with a population of under 2,500), that is to say, almost a quarter of the national population. Of the 199,000 localities in the country, 196,000 are in this category. However, "rural life in Mexico extends beyond these small localities." Sometimes a threshold of 15,000 inhabitants is considered since localities with a population lower than this also have rural characteristics. In this context, the rural population ends up being over 38 million people (over 37 per cent of the current national total). Far from being marginal, rural development (employment, income, production links, living conditions) constitutes a very relevant part of national development.[27]

As has been mentioned, the rural population carries out activities that are increasingly different from agriculture, including local trade, arts and crafts, material extraction, ecotourism, environmental services or salaried work in different occupations.

[27] INEGI, 2008 National Family Income and Expenditure Survey 2008; and CONAPO (National Population Council) 2008, Socio-demographic profile of the gainfully occupied population in the primary sector and its territorial distribution.

Nevertheless, agriculture still dominates the countryside, especially amongst the poorest population (such activity represented 42 per cent of family income in 2004).[28]

Therefore, though other production occupations are more and more important in the employment and income of the rural population, they do not exclude agriculture. There is a positive dynamic between both kinds of production activity, in which the growth of one favors the expansion of the other. Agricultural progress demands a greater number of supplies, direct employment and services, and allows for greater investment ability by rural families in other activities and creates greater dynamism in local markets. At the same time, growth in non-agricultural income favors investment abilities in agriculture, increases the possibilities for post-harvest activities, as well as vertical integration in production storage and transportation activities and creates greater local demand for sectoral production. The combined progress of agricultural and non-agricultural activities in rural areas also favors a better economic link with the intermediate cities system. The role of agricultural and rural development is essential for economic dynamism and job creation.

Its importance notwithstanding, agri-food GDP, like agricultural and livestock GDP, shows marginal growth and low participation in the national total (Table 9). In addition to this, the productivity of workers in the sector has during the last decade grown at rates that are still low, which is more related to low salary growth than to increased production by virtue of being better qualified. It is interesting that around 80 per cent of agricultural and livestock workers earn just the equivalent of up to twice the minimum wage, which includes 34.28 percent of workers who do not earn anything for their activity (Table 10).

[28] SAGARPA, Rural income behavior in Mexico 1994-2004.

Table 9. Agri-food and fishing sector. Income and employment. Main indicators

CONCEPT	2000	2001	2002	2003	2004	2005	2006	2007	2008 p/	2009 p/
NATIONAL GDP (Million pesos from 2003) 1/	7,520,344	7,448,713	7,455,361	7,555,804	7,861,679	8,113,679	8,513,900	8,798,342	8,929,456	8,345,649
Annual variation (%) 2/	6.0	-1.0	0.1	1.3	4.0	3.2	4.9	3.3	1.5	-6.5
AGRI-FOOD GDP (Million pesos 2003) 1/	630,222	643,937	650,237	663,254	685,839	692,228	721,378	739,413	750,380	756,232
Annual variation (%) 2/	2.9	2.2	1.0	2.0	3.4	0.9	4.2	2.5	1.5	0.8
AGRICULTURAL AND LIVESTOCK GDP (Million pesos from 2003) 1/	269,167	278,199	277,589	285,752	292,806	285,240	303,305	310,550	314,301	320,041
Annual variation (%) 2/	1.6	3.4	-0.2	2.9	2.5	-2.6	6.3	2.4	1.2	1.8
Agri-food GDP / National GDP (%)	***8.4***	***8.6***	***8.7***	***8.8***	***8.7***	***8.5***	***8.5***	***8.4***	***8.4***	***9.1***
Agricultural & Livestock GDP / National GDP (%)	***3.6***	***3.7***	***3.7***	***3.8***	***3.7***	***3.5***	***3.6***	***3.5***	***3.5***	***3.8***
PRODUCTION VALUE (Million current pesos)	284,507	304,717	304,204	335,207	375,976	379,314	416,159	468,773	527,464	N.D.
AGRICULTURE	159,975	170,850	169,585	192,421	210,640	200,251	232,709	269,951	305,951	N.D.
LIVESTOCK	124,532	133,867	134,619	142,786	165,336	179,063	183,450	198,822	221,514	N.D.
RURAL POPULATION under 2,500 inhabitants (Thousand persons) 3/	24,724	24,634	24,544	24,454	24,365	24,277	24,501	24,503	24,503	24,462
TOTAL GAINFULLY OCCUPIED POPULATION (Thousand persons) 1/	38,142	38,338	38,892	39,472	40,320	41,171	42,342	43,057	43,517	43,678
Annual variation (%)	N.D.	0.5	1.4	1.5	2.1	2.1	2.8	1.7	1.1	-0.5
POPULATION GAINFULLY EMPLOYED IN AGRICULTURAL & LIVESTOCK ACTIVITIES (Thousand persons) 2/	6,734	6,769	6,794	6,561	6,366	6,164	5,995	5,843	5,803	5,801
Annual variation (%)	N.D.	0.5	0.4	-3.4	-3.0	-3.2	-2.7	-2.5	-0.7	-1.5
POPULATION GAINFULLY EMPLOYED IN AGRICULTURAL & LIVESTOCK ACTIVITIES (Mexican Institute of Social Security) (Thousand persons) 4/	436	428	408	393	404	429	438	446	456	454
Population gainfully occupied in agricultural & livestock activities / Total population gainfully occupied (%)	***17.7***	***17.7***	***17.5***	***16.6***	***15.8***	***15.0***	***14.2***	***13.6***	***13.3***	***13.3***
Product generated by worker employed in agricultural & livestock activities (Pesos from 2003)	***39,969.5***	***41,101.5***	***40,857.6***	***43,555.6***	***45,996.5***	***46,278.6***	***50,593.0***	***53,153.3***	***54,165.3***	***55,171.0***
Annual variation (%) 2/	NA	2.8	-0.6	6.6	5.6	0.6	9.3	5.1	1.9	1.9
FINANCING FOR RURAL SECTOR/AFRI-FOOD GDP (%)	NA	NA	NA	NA	NA	NA	NA	NA	15.2	7.9

NA Not Available
p/ Preliminary data
1/ For 2009, figures corresponding to fourth year quarter.
2/ The figures correspond to the average of the four quarter of each year.
3/ 2000 XII General Population and Housing Census, 2005 II Population and Housing Count and CONAO estimates from 2006, SIAP estimated the figures from 2001 to 2004 by basing them on the 2000-2005 AMGR.
4/ The figures correspond to the average of the twelve months of each year and includes temporary countryside and urban workers and permanent workers.

SOURCE: Agri-food and Fishing Information Service (SIAP-SAGARPA) with data from STPS (Ministry of Labor and Social Welfare) and INEGI.

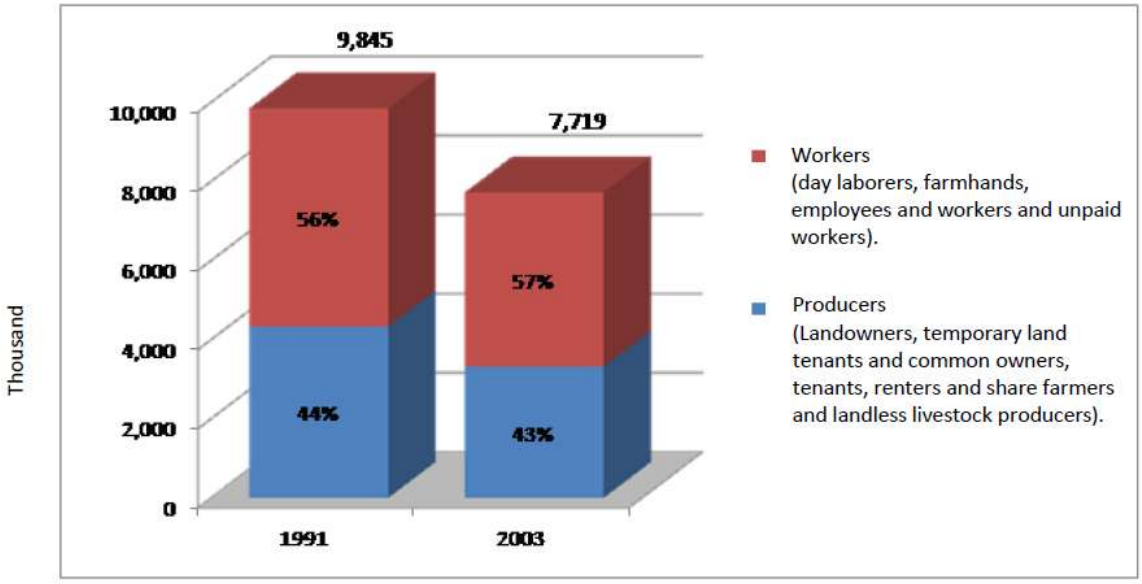
Table 10. Population gainfully occupied in the agriculture and livestock sector, according to income level (thousand)

	Agricultural & Livestock Activities				National			
	1995	2000	2005	2010	1995	2000	2005	2010
Total	**8,297**	**7,103**	**6,390**	**5,903**	**33,578**	**39,301**	**41,436**	**44,481**
Below 1 MW (Minimum Wage)	2,300	2,059	1,715	1,421	6,401	6,286	6,030	5,775
Between 1 and 2 MWs	1,593	1,615	1,229	1,253	10,403	11,225	9,111	10,023
Between 2 and 3 MWs	337	449	451	593	4,843	7,070	8,012	9,431
Between 3 and 5 MWs	192	204	241	199	3,184	5,366	7,506	7,525
Over 5 MWs	153	150	120	97	2,373	4,041	4,341	3,968
Receives no income 1/	3,371	2,403	2,412	2,024	5,123	4,158	4,308	3,917
Not specified 2/	351	223	223	316	1,251	1,155	2,129	3,842

Source: SAGARPA with data from INEGI. National Occupation and Employment Survey

The **big data** on rural population shows that this population is spread out over 196,350 localities (76 per cent of which have fewer than 100 inhabitants). Between 1991 and 2003, for example, the number of people working in agricultural and livestock production fell by 21 per cent and this trend continues.

Figure 7. Agricultural and Livestock Workers, 1991-2003 (thousand)



Source: Sergio Fadl (2011) THE AGRICULTURAL SECTOR IN MEXICO. DEVELOPMENT CHALLENGES AND OPPORTUNITIES[29]

In 1992 53.1 per cent of the total population (39 million) was living in asset poverty,[30] a figure which rose to 69 per cent (66 million) in 1996. From the end of the crisis of the mid-1990s and to a large extent thanks to the effectiveness of the compensatory programs applied by the government, poverty rates have shown a downward trend, reaching the minimum percentage equal to 42.6 per cent of the total population in 2006 (45 million). Nevertheless, poverty is greater and more acute in the rural sector.

In the case of asset poverty in rural areas, the public information available shows that in 1996 asset poverty reached a maximum rate of 80.7 per cent of the rural population (almost 25 million inhabitants) and a minimum rate of 54.7 per cent in 2006 (16.3 million inhabitants). In 2008 said rate rose to 60.6 per cent, which is equivalent to 18.1 million rural inhabitants, and in 2010 it fell to 50.3 per cent.

The eradication of poverty as a national priority through agricultural and rural development must play a leading role. According to data from the Human Development Report of the United National Development Program (UNDP), 2 per cent of the Mexican population lives on US$1.25 a day, 4.8 per cent lives on US$2 a day and 17.6 per cent lives below the national food poverty line. Therefore, 3.4 per cent of children under five are malnourished and 5 per cent of the population lives within the range of the prevalence of sub-nutrition.[31]

Unlike in other countries, where the emigration process has led to a greater number of people living in cities, in Mexico, the greater part of the poor population lives in the countryside. In 2008, of the 19.5 people living in food poverty, 7.2 million lived in cities and 12.2 million lived in rural areas (Table 11). That is to say, six out of every ten of those living in food poverty reside in rural areas (Figure 8). Therefore, the incidence of poverty amongst those living in the countryside is much greater than that of those living in cities. It is imperative—ethical and economical—to reduce poverty in Mexico and this undoubtedly involves attending to agricultural and rural development.

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[29] Paper presented by Sergio Fadl (SAGARPA) at the National Debate Forum: *Towards a New Development Project* of the National College of Economists, September 7, 2011.

[30] SEDESOL (Ministry of Social Development) defines three poverty levels: (1) food (extreme), when family members do not reach an acceptable level of food ingestion; (2) human capacity (moderate), when an acceptable level of food ingestion is reached, but a family cannot invest in health or education; and (3) asset (income), when a family can invest in health and education, but does not have money for housing, clothing or transportation.

[31] UNDP, Report on Human Development 2007-2008

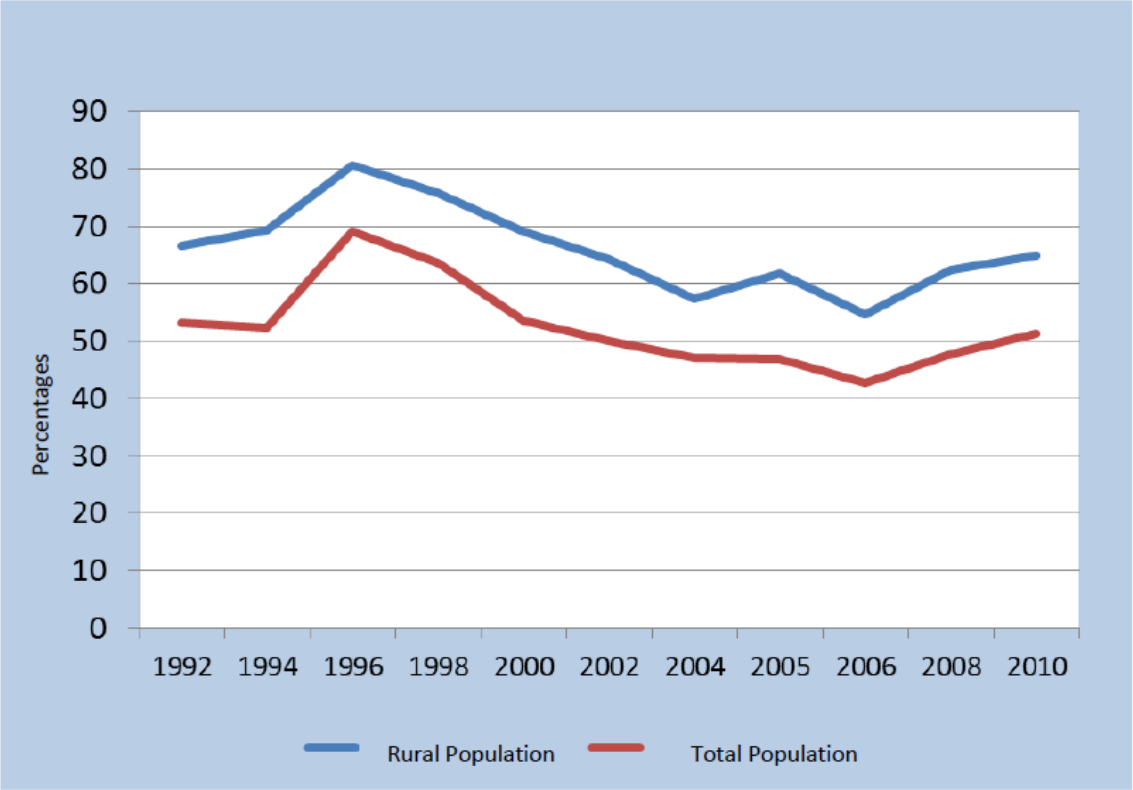
Table 11. 2008-2010 poverty indices in the rural sector (percentage of the rural and urban population)

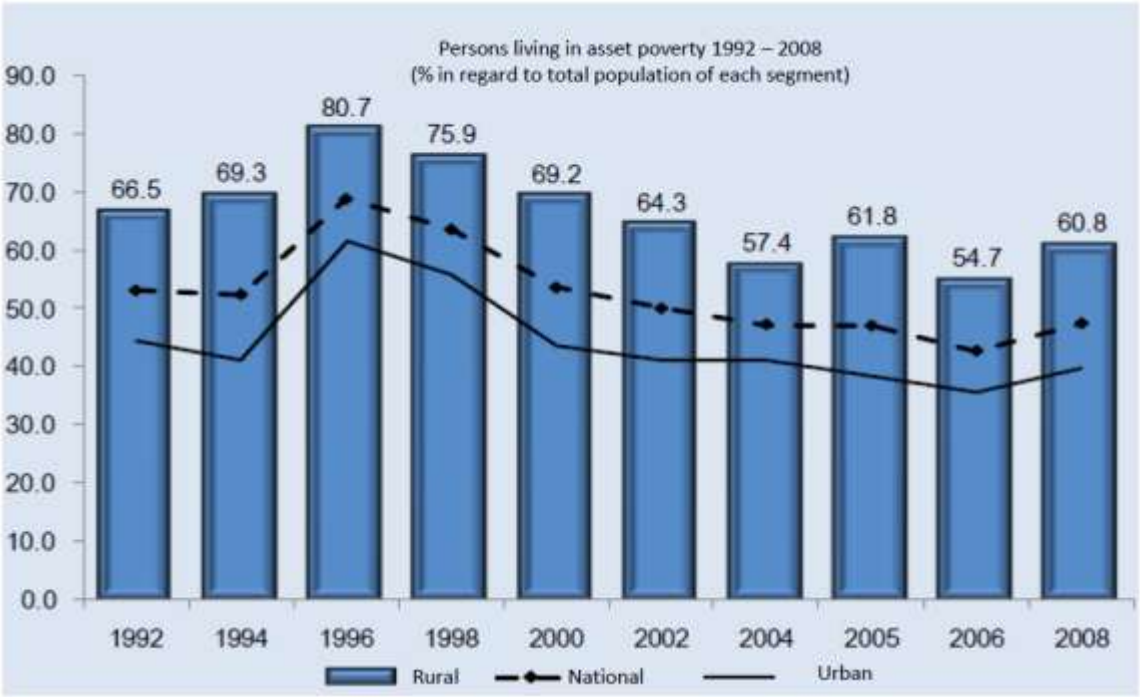
	Rural		Urban	
	2008	**2010**	**2008**	**2010**
Poverty				
Population living in poverty	62.4	64.9	39.1	40.5
Population living in moderate poverty	36.2	40.9	33.2	34.2
Population living in extreme poverty	26.2	23.9	5.9	6.3
Vulnerable population due to lack of social aspects	33.1	28.8	32.9	28.6
Vulnerable population due to income	0.7	1.1	5.6	7.2
Not poor nor vulnerable population	3.8	5.2	22.3	23.6
Social privation				
Population with at least one social aspect lacking	95.6	93.6	72.1	69.2
Population with at least three social aspects lacking	60.6	50.3	22.2	19.4
Indicators of lack of social aspects				
Educational poverty	36.3	33.9	17.6	16.6
Lack of access to health services	48.2	32.2	38.6	31.6
Lack of access to national security	86.2	81.9	58.6	54.3
Lack of housing quality and spaces	35.9	29.2	12.2	11
Lack of access to basic services at home	51.7	46.6	9.4	7.3
Lack of access to food	32.6	33.6	18.5	22.2
Wellbeing				
Population with an income below the minimum wellbeing line	32.8	35	11.9	14.7
Population with an income below the wellbeing line	63.1	66	44.8	47.7

Source: Coneval *(National Council for the Evaluation of Social Development Policy)* Estimates based on the 2008 and 2010 MCS-ENIGH *(Socio-economic Conditions Module of the National Family Income and Expenditure Survey)*

Rural development also means incorporating a significant economic potential into the country: the production capacity of over a quarter of the national population. Improvements in indices on nutrition, education, health, housing and access to services, as well as the economic dynamism of the countryside, stimulate the realization of the production potential of the rural population, thereby generating growth which can significantly improve living conditions in extensive areas of the country. Rural development, in turn, has a bearing on growth in internal demand, better inter-regional links and social equilibrium.

Figure 8. 1992-2010 percentage of persons living in poverty





Though progress has been recorded in internal food production in recent years and, as has been pointed out, in the export capacity of certain crops for specialized niches, restrictions in the sector persist, preventing higher levels of efficiency and productivity being achieved on a sustainable basis.

This, in turn, significantly limits the income generation of agricultural producers and the possibility to gradually reduce poverty levels and inequality inside the sector and in regard to the urban populaton.

Education level of rural producers

This section outlines the main demographic, social and economic characteristics of the rural sector in Mexico. The data used belongs primarily to the 2008 and 2010 National Family Income and Expenditure Survey (ENIGH).

In regard to the education level, very particular characteristics can be observed in the rural population of localities with less than 2,500 inhabitants. Sixteen per cent of the population over 15 years of age has no type of education while 71 per cent have only completed primary or secondary education. These data contrast with localities with over 15,000 inhabitants, where only 5 per cent of the population has no education and 45 per cent of persons over 15 years of age has completed senior high school, professional or postgraduate education.

It is important to mention that, according to the 2010 Population Census, the population over 15 years of age grew to 78,423,336. Of these, 7.19 per cent has no education, 12.5 per cent has not completed primary education, 16.02 per cent has completed primary education, 5.18 per cent has not completed secondary education, 22.32 per cent has completed secondary education, 19.3 per cent has advanced secondary education and only 16.52 per cent has higher education. As can be seen, the education level of 35 per cent of the population over 15 years of age is primary level or lower. This represents an **enormous human resources education challenge** in order to sustain the country's economic activities.

Size and heterogeneity of agricultural and livestock activities in Mexico

Mexican agriculture is split into a highly capitalized trade sector, a sector of small producers with links to the market, in particular the internal market, and a subsistence sector which produces for family consumption and whose income depends to a considerable extent on activities different from agricultural ones. In the case of Mexico, it is calculated that these subsectors constitute 15 percent, 35 per cent and 50 per cent respectively of the agricultural population, though in production terms these percentages would be reversed.[32]

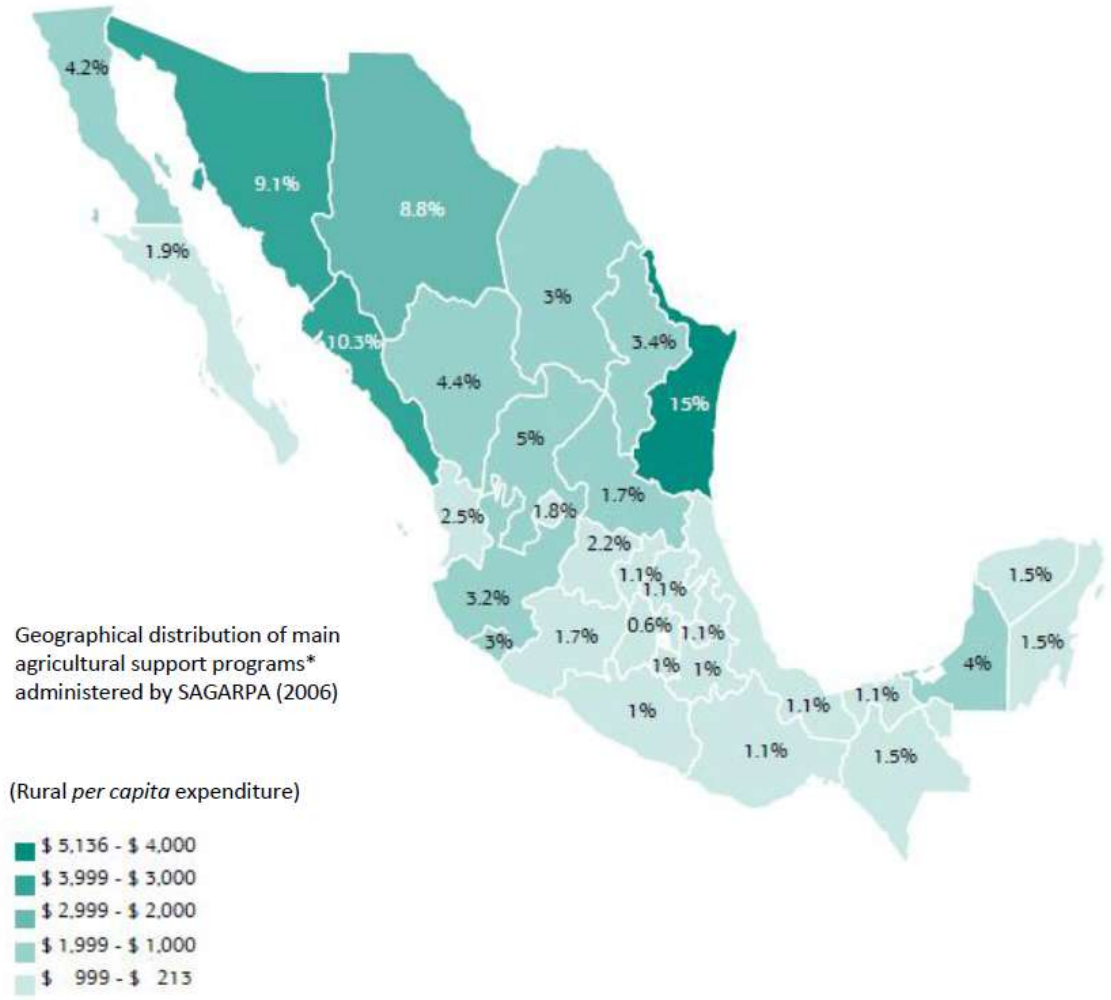
According to Fox and Haight, since the 1980s and 1990s the agriculture structure in Mexico has comprised four main groups: 1) a small number of well-equipped commercial producers, who controlled most of the land for irrigated crops; 2) a larger segment of small commercial producers; 3) a large majority of subsistence and sub-subsistence producers, who had to depend on a salaried job outside the family farm to complement their tiny pieces of land used for seasonal farming; and 4) a small group of salaried workers who possess no land. Small-scale agricultural producers do not have sufficient access to credit, supplies, markets and agroecologically appropriate technology to increase productivity and create more jobs. Nevertheless, 63 per cent of agricultural employment in Mexico is still located on farms of less than 5 hectares, according to the 2007 agricultural census. Even so, large commercial producers, especially those from the north, receive a very disproportionate fraction of agricultural

[32] OECD (2011) Analysis of agricultural outreach activities in Mexico. Organization for Economic Cooperation and Development, Paris

subsidies from the government, as Figure 9 shows.[33]

This shows the level of heterogeneity of production within the agricultural and livestock sector in Mexico, which imposes challenges for innovation generation since it is necessary to respond with different approaches and tools to both the competitivity oriented producers' needs and those of producers working at subsistence level.

Figure 9. Geographical concentration of agriculural expenditure by state SAGARPA 2006 (Mexican pesos per rural capita)



[33] Fox, J. and Haight, L. (2010) Mexican Agricultural Policy: Multiple Goals and Interests in Conflict, in Jonathan Fox and Libby Haight "Subsidies for Inequality. Public Maize Policies Starting From Free Trade," Woodrow Wilson International Center for Scholars, University of California, Santa Cruz

Source: * Programs included: Procampo (Traditional), Progan, Trade Support, Diesel and Alliance for the Countryside. Source: Fox and Haight (2010), Mexican Agricultural Policy: Multiple Goals and Interests in Conflict

Infrastructure for the agricultural and livestock sector

One of the defining elements in the sustained development of the agri-food sector is the availability of infrastructure for aspects such as irrigation, storage and transportation.

Irrigated land area represents 23.4 per cent while seasonal land area represents 76.6 per cent of total seeded land area. On the other hand, mechanization, whch is strongly linked to the existence of irrigation infrastructure, is highly concentrated in states which are home to commercial and competitive agriculture. Sinaloa, Sonoro, Chihuahua, Guanajuato and Tamaulipas have high percentages of their land area seeded using mechanization and irrigation (Tables 12 and 13). This concentration contributes to the existence of **large productivity differentials** and to the heterogeneity referred to in prevoius paragraphs.

In regard to highways, despite a significant effort being made during this government's term to repair this infrastructure, in 2008 only 36 per cent of roads were paved as a proportion of the total network.[34] No new ports have been built and there has been practically no growth in the entire railroad network in the last ten years. What *has* grown is the number of intermodal cargo terminals that have been put into operation, increasing from 52 in 2003 to 87 in 2011.

Table 12. Land area allocated to agricultural and livestock production

[34] National Institute of Statistics and Geography. Ministry of Communications and Transportation with date from the Federal Telecommunications Commission.

Concept	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Seeded land area (million hectares)	14.3	14.9	14.2	14.0	13.8	13.7	13.6	13.1	12.8	13.1	13.3	13.3	13.1	13.4
Irrigation land area/ Total seeded land area (%)	22.5	21.3	17.2	17.2	18.6	18.8	19.2	22.1	21.8	22.0	22.1	22.1	23.4	23.4
Seasonal land area/ Total seeded land area (%)	77.5	78.7	82.8	82.8	81.4	81.2	80.8	77.9	78.2	78.0	77.9	77.9	76.6	76.6
Land area allocated to agricultural activities/ Total land area (%)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Land area allocated to livestock activities/ Total land area (%)	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Land area allocated to forestry activities/ Total land area (%)	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0

Source: Ministry of Agriculture, Livestock, Rural Development, Fishing and Food. Bank of Mexico.

Table 13. Mechanized seeded land area by federal state, according to hydro modality. Agricultural year 2011
(hectares)

Federal State		Total	Seeded Land Area			
			Mechanized		Non-mechanized	
			Absolute	Relative	Absolute	Relative
Estados Unidos Mexicanos		15,591,466	5,828,862	100	9,762,605	100
25	Sinaloa	1,615,249	1,249,387	21.4	365,862	3.7
26	Sonora	628,875	595,725	10.2	33,149	0.3
8	Chihuahua	1,027,417	523,539	9	503,877	5.2
11	Guanajuato	961,936	508,236	8.7	453,700	4.6
28	Tamaulipas	1,387,114	466,253	8	920,861	9.4
16	Michoacán	838,280	386,782	6.6	451,498	4.6
14	Jalisco	1,248,458	241,389	4.1	1,007,069	10.3
2	Baja California	225,138	184,100	3.2	41,038	0.4
32	Zacatecas	1,124,242	155,024	2.7	969,219	9.9
5	Coahuila	230,363	150,956	2.6	79,407	0.8
21	Puebla	594,608	145,662	2.5	448,947	4.6
13	Hidalgo	340,028	140,812	2.4	199,217	2
15	México	635,417	132,361	2.3	503,056	5.2
10	Durango	566,951	132,203	2.3	434,748	4.5
24	San Luis Potosí	512,016	122,332	2.1	389,684	4
30	Veracruz	840,334	104,333	1.8	736,000	7.5
20	Oaxaca	665,807	80,737	1.4	585,071	6
19	Nuevo León	170,014	75,510	1.3	94,504	1
6	Colima	132,190	65,442	1.1	66,748	0.7
22	Querétaro	145,254	65,423	1.1	79,831	0.8
18	Nayarit	247,395	60,642	1	186,754	1.9
12	Guerrero	405,313	58,344	1	346,969	3.6
1	Aguascalientes	111,582	45,309	0.8	66,273	0.7
3	Baja California S	39,874	39,874	0.7	0	0
7	Chiapas	271,881	24,019	0.4	247,862	2.5
17	Morelos	105,928	23,085	0.4	82,842	0.8
29	Tlaxcala	215,590	21,845	0.4	193,745	2
4	Campeche	131,718	15,635	0.3	116,083	1.2
31	Yucatán	32,875	7,754	0.1	25,121	0.3
23	Quintana Roo	45,104	3,390	0.1	41,714	0.4
9	Distrito Federal	16,901	1,932	0	14,969	0.2
27	Tabasco	77,616	827	0	76,789	0.8

Note: The data are in order of highest to lowest according to mechanized seeded land area with hydro modality irrigation

Stadistics on technological and services use on agricultural land area. 2011 tables
Agri-food and Fishing Information Service (SIAP)
http://www.siap.gob.mx/opt/agricultura/tecnificacion/Estadistica.pdf

Production and productivity

Basic crops production had frankly mediocre growth rates between 1994 and 2010, except in the cases of sesame seed and barely (Table 14). Yields of these crops have moderately increased, primarily on irrigated land areas, but **the yields achieved are still low** compared to averages in other countries and are insufficient to reach profitability and competitivity goals. **The increase in agricultural yields is without a doubt one of the great challenges for the innovation system**.

Meat production increased moderately between 2003, when 4.8 million tons were produced, and 2011, when it reached 5.8 million tons. In the same period fish production saw a slight reduction, from 1.4 million tons in 2003 to 1.3 million tons in 2011.

In regard to fishing, "in an international context, Mexico is increasingly a fishing country: from over 160 countries carrying out this activity, it moved from thirtieth place in contribution to total world catch, as an average of the period 1950-1980, to seventeenth place during the last twenty years, and today produces almost 1.5 per cent of the total global volume. According to world catch projections, to maintain this relative position, Mexico should increase its production to between 20 and 55 per cent for 2030. Globally, it is acknowledged that for some regions of the world the objective of increasing production seems unachievable, therefore, such world projection is based on countries like Mexico, where there is still potential and underexploited fishing."[35]

What is significant is that good fishing performance is concentrated solely in the northeastern region of the country, which means that production growth is connected to the improvement in performance in other regions, which requires technology and infrastructure.

"The almost 11,000 kilometers of national coastline are served by 72 ports which carry out fishing activities. Of these, 21 are located in the northeast region, eight in the Tropical Pacific, 32 in the Gulf of Mexico and 11 in the Caribbean Sea. According to official figures, national port infrastructure dedicated to fishing totals 34,125 meters of useful quay. This would mean a proportion, which seems appropriate, of nine meters for each of the approximately 3,600 vessels, which make up the larger fleet. Conversely, this distance would barely correspond to 0.3 meters for each of the 100,000 plus minor vessels.

In terms of coverage, on average, the fishing operations carried out along the 150 kilometers of coastline would correspond to each port. This involves navigation distances that may be suitable for the general characteristics of major vessels, but which would generally be above the average autonomous capacity of the minor

[35] CONAPESCA (2008) op. cit. p. 3

fleet. This forces the minor fleet to access only those resources closest to port facilities, or to carry out their operations without the advantages and facilities which this infrastructure would provide and without all kinds of control mechanisms which could be implemented within this infrastructure."[36] This leaves no doubt that infrastructure favors large-scale use and offers very unfavorable conditions for small producers.

Table 14. Ten basic crops roduction (thousand tons)

Product	1994-1997 Average	1998-2001 Average	2002-2005 Average	2006-2009 Average	2009	2010*	AAGR** 1994-2010
Maize	18,067.7	18,463.1	20,255.9	22,489.8	20,142.8	185,079.0	0.1%
Milo	5,098.0	6,151.0	6,123.5	6,105.6	6,108.1	6,365.9	3.4%
Wheat	3,662.7	3,256.2	2,822.1	3,805.8	4,116.2	3,655.5	-0.8%
Bean	1,237.4	1,067.6	1,238.6	1,133.0	1,041.3	1,109.4	-1.3%
Farro	462.6	584.8	877.6	705.6	518.8	666.7	5.0%
Raw cotton	590.7	409.2	279.8	367.6	278.5	362.5	0.4%
Rough rice	401.0	340.7	267.5	279.8	263.0	177.0	-4.6%
Soy	238.2	126.8	133.2	110.9	120.9	142.7	-7.8%
Safflower	130.5	160.5	144.7	89.9	76.7	98.4	2.7%
Sesame seed	24.7	36.7	26.1	28.3	28.5	35.6	9.1%
Total	29,913.6	30,596.4	32,169.0	35,116.3	32,695.0	31,121.6	0.4%

***/ Preliminary figures**
****/ Average Annual Growth Rate**

SOURCE: SAGARPA with data from the Agri-food and Fishing Information Service

Table 15. Ten basic crops yield (thousand tons)

Product	1994-1997 Average			2006-2009 Average			2010			2006-2009/1994-1997 Var %		
	Irrigation	Seasonal	Weighted Average	Irrigation	Seasonal	Weighted Average	Irrigation	Seasonal	Weighted Average	Irrigation	Seasonal	Weighted Average
Rough rice	5.474	3.456	4.403	6.325	3.343	4.563	6.414	3.747	5.58	15.5	-3.3	3.6
Bean	1.496	0.485	0.633	1.644	0.628	0.769	1.557	0.532	0.713	9.9	29.4	21.4
Maize	4.719	1.732	2.284	7.157	2.203	3.192	7.535	1.966	3.278	51.7	27.2	39.7
Wheat	5.185	1.724	4.235	5.862	2.088	5.091	6.133	2.099	5.499	13	21.1	20.2
Raw cotton	2.792	1.458	2.459	3.78	1.238	3.714	3.906	1.336	3.881	35.4	-15.1	51
Sesame seed	1.81	0.53	0.533	1.973	0.575	0.582	0.792	0.579	0.583	9	8.5	9.2
Safflower	0.725	0.684	1.371	0.799	0.618	1.227	2.275	0.499	1.164	10.2	-9.6	-10.5
Soy	1.63	1.34	1.468	2	1.646	1.699	1.31	1.096	1.119	22.7	22.8	15.7
Farro	4.799	1.649	2.157	5.525	1.878	2.43	5.906	1.888	2.586	15.1	13.9	12.7
Milo	5.322	2.354	3.039	5.767	2.611	3.533	6.037	3.105	4.053	8.3	10.9	16.3

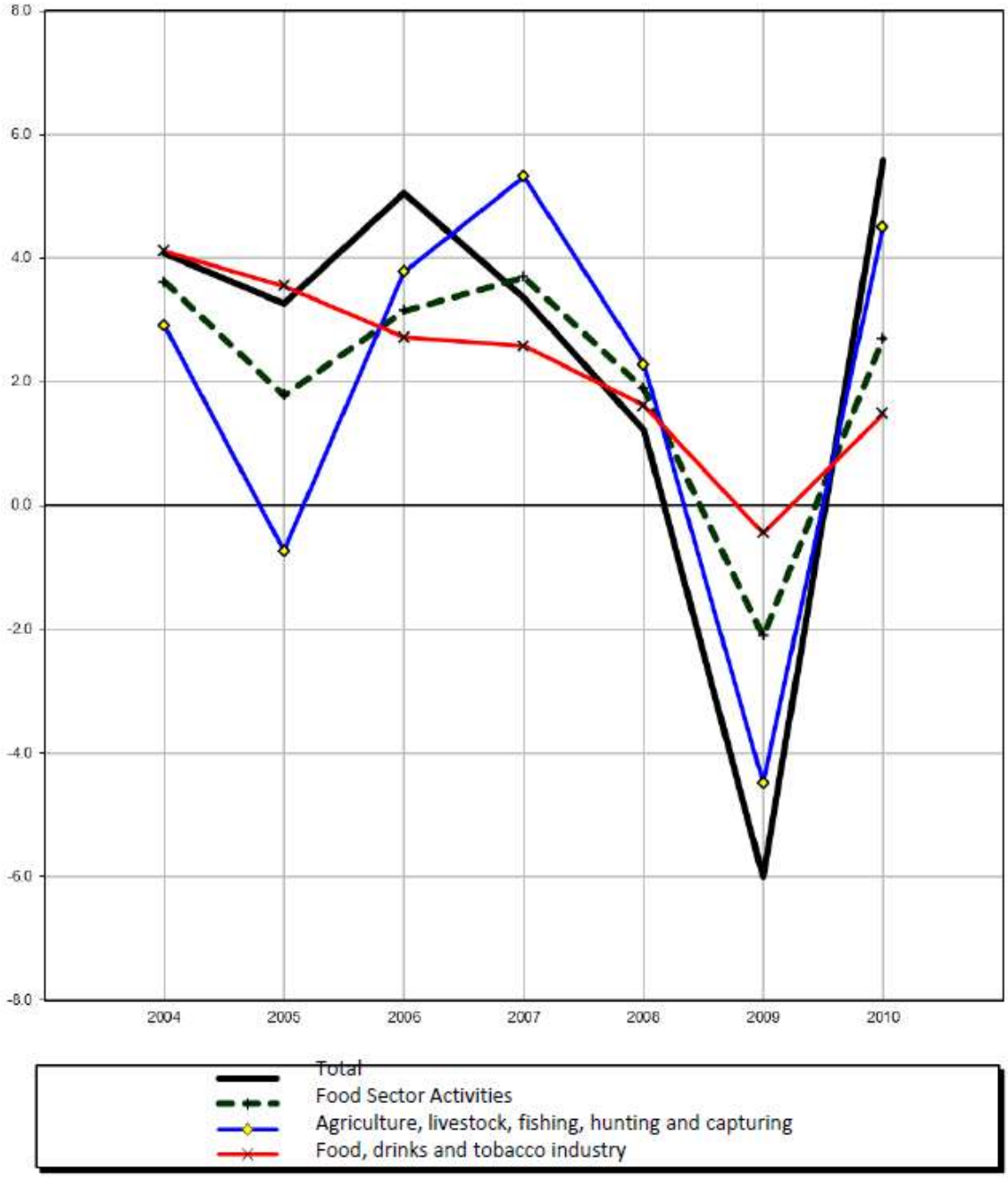
SOURCE: SAGARPA with data from the Agri-food and Fishing Information Service

[36] CONAPESCA (2008) op. cit. p. 11

And so a group of indicators showing that sector performance is not in tandem with the goals set out can be observed. Figure 10 illustrates how one of the key performance indicators of the agri-food sector—gross added value—is pulled along by the economic crisis, but is less able to recover.

These are unequivocal signs of the need to implement new policies for this sector with the aim of making its productivity more dynamic and improving its presence in the national economy in recognition of the strategic role it plays in the food industry and job creation.

Figure 10. Evolution of total gross added value and the food sector (annual percentage variation).



Source: INEGI. System of National Accounts of Mexico.
Assets and Services Accounts 2006-2010 2003 Basis.
Second Version. Aguascalientes, Ags. 2011.

Use of agricultural supplies

One of the determining factors in agricultural yields is undoubteldy the use of supplies such as water, fertilizers, agrochemicals and enhanced seeds. We have already presented statistics on the use of irrigation water. With regard to chemical fertilizers in general, we can say that they are used on two thirds of seeded land areas (Table 16).

With regard to seed use, only 43 per cent of seeded land areas use enhanced seeds and the remaining 57 per cent use creole seeds. It is notable that the culture of using enhanced seeds is much more common in states with commercial agriculture and much less common in states with a predominantly rural economy (Table 16).

It is worth mentioning that the National Seed Inspection and Certification Service has made a significant effort to increase the use of certified seeds, which has resulted in a register of 1,827 varieties of 53 species in the National Catalog of Vegetable Varieties (Figure 11). It is also noteworthy that a number of public institutions (notably INIFAP – National Institute of Forestry, Agricultural and Fisheries Research) have registered varieties in the catalog. Nevertheless, there must be no doubt that the existence of this registry does not mean that these varieties enter into comercial use since there are not many successful experiences of multiplication and distribution of such varieties through commercial channels. This document's section on technology transfer offers a more detailed analysis of the insufficient links between research institutions and the seed industry, which has created an obstacle to using locally developed seeds. Furthermore, the seed industry has resorted to seed import and distribution activities with little research carried out inside the country.

Table 16. Seeded land area by federal state, according to use of chemical fertilizers
Agricultural year 2011 (hectares)

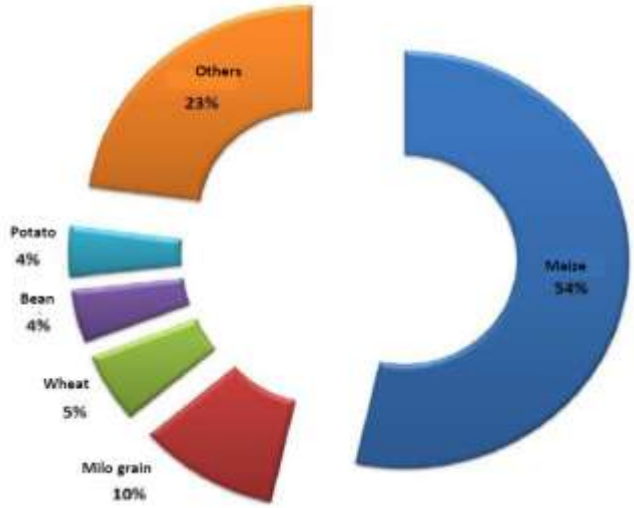
Federal State		Total	Seeded Land Area: Fertilized with Chemicals Absolute	Fertilized with Chemicals Relative	Not Fertilized with Chemicals Absolute	Not Fertilized with Chemicals Relative
Estados Unidos Mexicanos		22,136,742	14,481,947	100	7,654,795	100
25	Sinaloa	1,626,551	1,535,503	10.6	91,048	1.2
14	Jalisco	1,592,094	1,207,559	8.3	384,535	5
30	Veracruz	1,456,305	1,001,749	6.9	454,556	5.9
16	Michoacán	1,081,740	969,454	6.7	112,286	1.5
11	Guanajuato	1,074,542	931,654	6.4	142,888	1.9
28	Tamaulipas	1,477,137	869,577	6	607,559	7.9
8	Chihuahua	1,031,680	846,658	5.8	185,022	2.4
32	Zacatecas	1,137,011	820,145	5.7	316,866	4.1
15	México	872,271	764,968	5.3	107,303	1.4
21	Puebla	1,011,921	681,976	4.7	329,945	4.3
7	Chiapas	1,449,954	656,290	4.5	793,664	10.4
20	Oaxaca	1,421,468	622,452	4.3	799,017	10.4
26	Sonora	630,491	619,996	4.3	10,495	0.1
12	Guerrero	870,819	548,526	3.8	322,292	4.2
10	Durango	695,285	360,972	2.5	334,312	4.4
29	Tlaxcala	248,777	244,045	1.7	4,731	0.1
18	Nayarit	402,677	234,214	1.6	168,462	2.2
2	Baja California	225,138	184,100	1.3	41,038	0.5
24	San Luis Potosí	645,017	161,263	1.1	483,755	6.3
13	Hidalgo	578,855	151,881	1	426,974	5.6
4	Campeche	235,906	131,773	0.9	104,132	1.4
27	Tabasco	239,904	128,747	0.9	111,157	1.5
5	Coahuila	291,237	120,482	0.8	170,755	2.2
31	Yucatán	778,297	118,916	0.8	659,381	8.6
17	Morelos	134,072	112,224	0.8	21,849	0.3
6	Colima	158,368	110,826	0.8	47,542	0.6
22	Querétaro	169,082	105,975	0.7	63,107	0.8
1	Aguascalientes	122,812	66,008	0.5	56,804	0.7
23	Quintana Roo	115,541	58,702	0.4	56,840	0.7
19	Nuevo León	299,953	57,512	0.4	242,441	3.2
3	Baja California S	40,711	39,925	0.3	786	0
9	Distrito Federal	21,127	17,874	0.1	3,253	0

Note: The data are in order of highest to lowest according to mechanized seeded land area with chemical fertilizers

Source: Agri-food and Fishing Information Service (SIAP). Statistics on technology and services use on agricultural land area. 2011 Tables

Figure 11. Main species in National Vegetable There are a total of 53 species, of which 1,827

Varieties Catalog (NVVC)



Source: 2011 SNICS archives (National Seed Inspection and Certification Service).

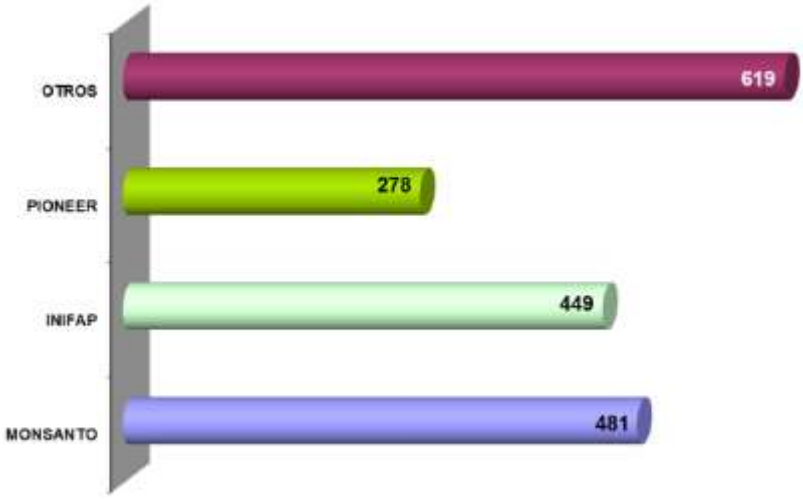
are varieties registered in the NVVC. They are primarily maize (978), milo grain (186), wheat (98), bean (72), and potato (50) while "Others" includes cactus paddle (46), cempoálxochitl (30), chili (23), rice (21), oatmeal (20), avocado (17), safflower (17), garbanzo (17), soy (17), peach (16), chayote (14) barley (12), coconut tree (11), green tomato (11), grasses (10), dragon fruit (10), garlic (9), tigridia flower (9), sesame seed (8), amaranth (8), poinsettia (8), peanut (6), strawberry (6), fava bean (6), agave (5), rape seed (5), dahlia (5), guava (5), Aztec lily (5), crab apple (5), hibiscus (4), bulgur (4), Mexican lime (3), mango (3), cotton (2), onion (2), kidney bean (2), castor bean (2), papaya (2), artichoke (1) alfalfa (1), cofee (1), apricot (1), quinoa (1), echeveria gibbiflora (1), pecan (1) and sorghum forage (1).

Varieties registered in the NVVC by applicant

The companies Semillas y Agroproductos Monsanto, S. A. de C. V. (Monsanto) and PHI México, S. A. de C. V. (Pioneer) only registered varieties of Maize and Milo. In addition, Monsanto presented two varieties of Soya.

INIFAP has descriptions of varieties of 32 species from a total of 53 included in the NVVC.

Figure 12. Varieties registered by companies



source: 2011 SNICS archives.

Table 17. Seeded land area by federal state according to use of cyclical crops enhanced and creole seed. Agricultural year 2011 (hectares)

Federal State		Seeded Land Area				
		Total	Enhanced		Creole	
			Absolute	Relative	Absolute	Relative
Estados Unidos Mexicanos		15,711,327	9,981,151	100	5,730,176	100
25	Sinaloa	1,514,165	1,489,488	14.9	24,678	0.4
28	Tamaulipas	1,211,889	1,075,531	10.8	136,358	2.4
14	Jalisco	941,587	862,183	8.6	79,404	1.4
11	Guanajuato	997,477	854,352	8.6	143,125	2.5
8	Chihuahua	863,337	748,646	7.5	114,690	2
16	Michoacán	763,728	602,267	6	161,461	2.8
26	Sonora	547,601	544,042	5.5	3,559	0.1
10	Durango	637,624	455,903	4.6	181,721	3.2
30	Veracruz	667,896	374,773	3.8	293,123	5.1
12	Guerrero	561,013	313,941	3.1	247,072	4.3
21	Puebla	845,742	311,558	3.1	534,185	9.3
15	México	743,077	266,428	2.7	476,649	8.3
32	Zacatecas	1,063,386	266,274	2.7	797,111	13.9
7	Chiapas	887,118	250,773	2.5	636,345	11.1
24	San Luis Potosí	419,680	183,715	1.8	235,965	4.1
13	Hidalgo	456,856	177,807	1.8	279,048	4.9
18	Nayarit	210,216	167,469	1.7	42,748	0.7
29	Tlaxcala	242,892	146,905	1.5	95,987	1.7
2	Baja California	182,769	143,195	1.4	39,574	0.7
5	Coahuila	151,091	119,081	1.2	32,010	0.6
4	Campeche	211,823	109,207	1.1	102,616	1.8
17	Morelos	98,864	97,520	1	1,343	0
20	Oaxaca	712,161	85,652	0.9	626,509	10.9
22	Querétaro	157,656	73,561	0.7	84,096	1.5
19	Nuevo León	97,052	57,891	0.6	39,161	0.7
27	Tabasco	113,146	54,625	0.5	58,521	1
1	Aguascalientes	101,041	46,675	0.5	54,367	0.9
31	Yucatán	157,115	29,253	0.3	127,862	2.2
3	Baja California S	28,584	28,476	0.3	108	0
6	Colima	27,450	23,073	0.2	4,377	0.1
23	Quintana Roo	81,000	18,590	0.2	62,411	1.1
9	Distrito Federal	16,294	2,298	0	13,997	0.2

Note: The data are in order of highest to lowest according to seeded land area

Source: Agri-food and Fishing Information Service (SIAP). Statistics on technology and services use on agricultural land area. 2011 Tables

Summary of the production dimension

- Whichever way you look at it—production scales, income level, technological patterns and agroecological systems—Mexican agriculture is extremely heterogeneous since it has the most diverse production unit systems and sizes.
- Commercial agriculture enjoys high performance and uses technological supplies and the best land and infrasructure, while at the other end there is a large number of subsistence producers, which means that the countryside is the stronghold of the poorest population in the country due to its average low technological level and the deterioration of the natural resources it uses.
- The level of investment channelled into the sector is very low and inefficient, which is reflected in the fact that it does not enjoy the priority it deserves due to its strategic role and social impact.
- Public financial support for the sector is unequally distributed and benefits the best performing regions, contributing to a widening of productivity gaps.
- Agricultural and livestock production in Mexico has increased, but at very low rates. Key crop yields are still low and their substancial increase remains one of the pending issues of the country's innovation system.
- More effective policies encouraging better equality and access to the benefits of technical change are needed for different regions and types of producers.

CHAPTER 3. SCIENCE, TECHNOLOGY AND INNOVATION DIMENSION

Research resources

The passing of the Law on Science and Technology in Mexico in 2002 led to setting the goal of investment in scientific and technological activities reaching 1 per cent of GDP. After 10 years, investment has not even reached half this level.[37] In fact, progress has been insignificant, rising from 0.39 per cent of GDP in 2003 to 0.42 per cent in 2010.

In regard to expenditure in the agri-food sector, there has been a reduction in federal expenditure in science and technology in real terms with levels remaining very low (Table 18).

Table 18. Federal expenditure in science and technology by administrative sector, 2003-2010
(Million pesos 2010)

Branch	Administrative Sector	2003	2004	2005	2006	2007	2008	2009	2010
08	Agriculture, Livestock, Rural Development, Fishing & Food	2,854.99	2,632.54	2,250.37	2,568.85	2,696.89	2,744.95	2,695.98	2,539.81
09	Communication & Transportation	160.35	98.55	116.11	144.61	136.34	180.05	117.80	140.46
10	Economy	821.56	855.39	1,069.86	1,332.15	1,676.61	2,521.89	1,511.80	1,807.79
11	Public Education	14,495.57	13,418.23	14,914.31	14,470.03	13,954.41	13,991.30	14,114.44	15,848.31
12	Health & Social Security	3,277.97	1,935.04	2,536.86	2,481.65	3,024.48	4,431.49	4,400.99	4,093.41
13	Marine	472.69	183.24	234.05	252.52	279.55	427.65	386.60	391.92
16	Environment & Natural Resources	700.06	734.21	719.57	680.51	692.36	637.50	652.51	737.09
17	Attorney General of the Republic	42.94	29.47	13.00	10.26	9.26	118.02	95.73	117.94
18	Energy	7,797.01	6,074.72	6,905.58	6,057.41	6,126.09	7,226.25	6,258.81	9,561.43
38	Conacyt	12,693.79	11,995.92	11,902.89	12,531.78	12,652.57	15,132.80	17,659.38	19,004.80
	Others	134.72	46.32	86.34	25.99	98.36	139.82	89.51	193.42
	Total	**43,451.63**	**38,003.63**	**40,748.94**	**40,555.76**	**41,346.92**	**47,551.72**	**47,983.54**	**54,436.39**

Sources: SHCP (Ministry of Communication and Transportation), Public Federal Treasury Account, 2003-2010.
INEGI, National Accounts System in Mexico

Reductions in expenditure have been reflected in research resources for the main institutions in the agri-food sector, as shown by Table 19, where it is evident that resource levels have dropped, but that there are also large fluctuations between periods, which prevents appropriate institutional planning.

[37] Interestingly, in 2012 the Scientific and Technological Consultative Forum filed a complaint "against whoever is responsible" for the noncompliance of this provision of the Law on Science and Technology. The purpose of the complaint is to show that the country has not acted in accordance with its discourse and with its legal framework in this regard and that resources are insufficient and maintained at the same level, despite administration changes.

Table 19. Participation of administrative sectors and main bodies in federal expenditure in science and technology, 2003-2010 (Million pesos 2010)

Administrative Sector Body	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture, Livestock, Rural Development, Fishing & Food	**2,854.99**	**2,632.54**	**2,250.40**	**2,568.85**	**2,696.89**	**2,744.95**	**2,695.98**	**2,539.81**
National Institute of Forestry, Agricultural and Livestock Research	1,570.17	1,580.42	1,366.50	1,483.68	1,481.03	1,363.53	1,414.63	1,203.61
College of Postgraduates	703.14	574.16	576.67	715.94	850.13	882.83	812.87	854.68
Chapingo Autonomous University	232.16	347.15	306.85	294.25	291.42	391.65	224.84	191.11
National Fisheries Institute	239.77	24.45	0.22	74.84	74.11	92.05	213.38	202.20
Antonio Narro Autonomous Agrarian University	57.82	32.88						
Others	51.94	73.49	0.16	0.15	0.21	14.89	30.26	88.22

Sources: SHCP (Ministry of Communication and Transportation), Public Federal Treasury Account, 2003-2010. INEGI, National Accounts System in Mexico

Moreover, if we compare the behavior of investment in innovation activities in the sector with that of subsidies for producers (PROCAMPO grows and innovation falls), we can easily conclude that the priority level given to innovation is low,[38] which rather biases the application of resources to short-term programs.

Table 20. SAGARPA public policies

	Year (million pesos)	
	2011	2012
PROCAMPO	13,000	14,000
Innovation	2,966	1,834

Source: **SAGARPA (2012), Technological Development for the Agri-food Sector and its Link to Engineers, report presented by Dr. Arnulfo del Toro, Deputy Minister of Agriculture, SAGARPA, Mexico, September 2012.**

Expenditure on Research and Development (R&D) also has low importance if expressed as a percentage of the SAGARPA operating budget, which represents less than 3 per cent of the Ministry budget.

[38] SAGARPA (2012), Technological Development for the Agri-food Sector and its Link to Engineers, report presented by Dr. Arnulfo del Toro, Deputy Minister of Agriculture, SAGARPA, Mexico, September, 2012.

Table 21. Expenditure on R&D as a proportion of the SAGARPA operating budget

Year	Total	R&D	%
2010	73,600.00	450.00	0.006%
2011	73,821.34	2,966.67	0.040%
2012	67,000.00	1,834.00	0.027%

Note: INIFAP, Chapingo, COLPOS (College of Postgraduates), INAPESCA (National Fisheries Institute) and CSAEGRO (Higher Agricultural and Liverstock College of the State of Guerrero) budgets are not provided (5,043 millon pesos)[39].
Source: SAGARPA (2012), Technological Development for the Agri-food Sector and its Link to Engineers, report presented by Dr. Arnulfo del Toro, Deputy Minister of Agriculture, SAGARPA, Mexico, September 2012.

Human resources for research and provision of outreach services

The main support of an innovation system undoubtedly constitutes the quantity and quality of human resources for the tasks of research and promotion of innovations. In Mexico, the increased education level of human resources for research in the agri-food sector is evident. In the period 2000-2010, 1,457 doctors graduated in agricultural and livestock sciences (Table 21), which is a significant figure if we take into account that in 2010 the College of Postgraduates had 222 national reseachers and INIFAP had 169. The availability of doctors educated during this decade could substantially increase the research template if the appropriate policies and resources existed. The problem is that the policy of creating tenured positions in institutions does not lead to the creation of new positions for researchers (though INIFAP has just obtained authorization for new tendured positions to refresh its research team), which leads to temporary hiring systems (by project) which impact negatively on the motiviation of new reserachers. Therefore, it can generally be said that the average age of researchers is still rising and this is creating an phenomenon of aging. Younger researchers must be incorporated and trained in new disciplines, which impact technological development in the sector.

There has been some response, since, when it comes to the number of members of the National System of Researchers, Biotechnology and Agricultural and Livestock

[39] SAGARPA op. cit.

Sciences is one of the areas which enjoyed stronger growth, increasing from 700 in 2000 to 1,866 in 2010 (Table 22).

It is evident, then, that the research base has grown and that, thanks to the graduation of more doctors, this base could increase significantly. Nevertheless, it is fundamental that we reflect on the performance and direction of research since it is clear that, as this section illustrates, **research has grown in traditional results, but not in the generation of knowledge stocks** by virtue of it not being directed at creating solutions for problems in the sector.

In regard to the professionals working in agricultural outreach, it is important to highlight the conclusion of the 2011 OECD study in the sense that "In Mexico there is no specific agricultural outreach service as such. Rather, producers receive technical assistance by accessing the different SAGARPA support programs as an integral part of such assistance. Technical assistance is carried out through private sector contractors, that is to say, professional service providers (PSP), whose function is to put the programs into practice at the level of agricultural use. The professional services defined for these purposes include strategic planning, project formulation, access to public resources, technical consulting, commercial strategies and training. Their objective is to support producers so that they can increase their efficiency and to facilitate their incorporation into value chains." [40] As can be deduced, the figure of the outreach workers of the 1960s has been replaced by so-called Professional Service Providers.

The package of functions sought to be allocated to PSPs is very extensive, which has caused them to be very scattered. Moreover, the absence of indicators to evaluate their performance has caused the results to be very heterogeneous. The perception of producers is that the change is not working and that the real impact of PSPs on technology promotion is much lower than that desired. In addition to this, the PSP payment scheme is not very encouraging since they are hired per product or very short time period and payment is constantly delayed, which also reduces motivation.

In regard to coverage of this training, in 2011 there were 5,073 registered PSPs (Figure 13). As we can see in Table 24, the states that have used technical assistance more are those involved in commercial agriculture (as in the case of agricultural supply consumption). There are states where the rate of use of technical assistance

[40] OECD (2011), Analysis of Agricultural Outreach Activities in Mexico, Organization for Economic Cooperation and Development, Paris, p. 5

services is frankly low, which implies that access to technology will also be at this level.

Table 21. Number of graduates from doctorate programs by science area, 2000-2010

Year	Exact & Natural Sciences	Engineering & Technology	Agricultural & Livestock Sciences	Health Sciences	Social & Administrative Sciences	Education & Humanities	Total
2000	328	130	92	119	281	126	1,076
2001	351	159	84	110	227	144	1,075
2002	386	199	93	145	294	121	1,238
2003	381	228	139	139	365	162	1,414
2004	440	257	137	224	419	201	1,678
2005	493	370	109	263	462	213	1,910
2006	483	395	142	294	538	260	2,112
2007	513	412	160	234	688	276	2,283
2008	539	485	190	230	682	428	2,554
2009	530	547	141	285	747	474	2,724
2010 e/	590	575	170	325	775	483	2,918
	5,034	**3,757**	**1,457**	**2,368**	**5,478**	**2,888**	**20,982**

Refers to the number of persons who have obtained the title of Doctor.
e/ Estimated figures

Source: Conacyt (National Council of Science and Technology), Doctorate Graduates Survey, 2010.

Table 22. Number of members of the SNI (National System of Researchers) by science area, 2000-2010

SNI MEMBERS BY SCIENCE AREA 2000-2010
Number

Year	Physical-Mathematical & Earth Sciences	Biology & Chemistry	Medicine & Health Sciences	Humanities & Behavioral Sciences	Social Sciences	Biotechnology & Agricultural & Livestock Sciences	Engineering	Total
2000	1,569	1,435	765	1,269	810	700	918	7,466
2001	1,612	1,436	846	1,362	920	856	986	8,018
2002	1,770	1,661	926	1,552	1,097	1,011	1,182	9,199
2003	1,770	1,661	926	1,552	1,097	1,011	1,182	9,199
2004	1,878	1,767	1,043	1,700	1,233	1,131	1,437	10,189
2005	1,968	1,776	1,168	1,798	1,369	1,257	1,568	10,904
2006	2,074	1,891	1,343	1,964	1,608	1,441	1,775	12,096
2007	2,277	2,179	1,429	2,169	1,854	1,586	1,991	13,485
2008	2,478	2,443	1,445	2,326	2,187	1,711	2,091	14,681
2009	2,600	2,704	1,440	2,394	2,469	1,720	2,238	15,565
2010 p/	2,708	2,905	1,592	2,465	2,616	1,866	2448	16,600

p/ Preliminary figures

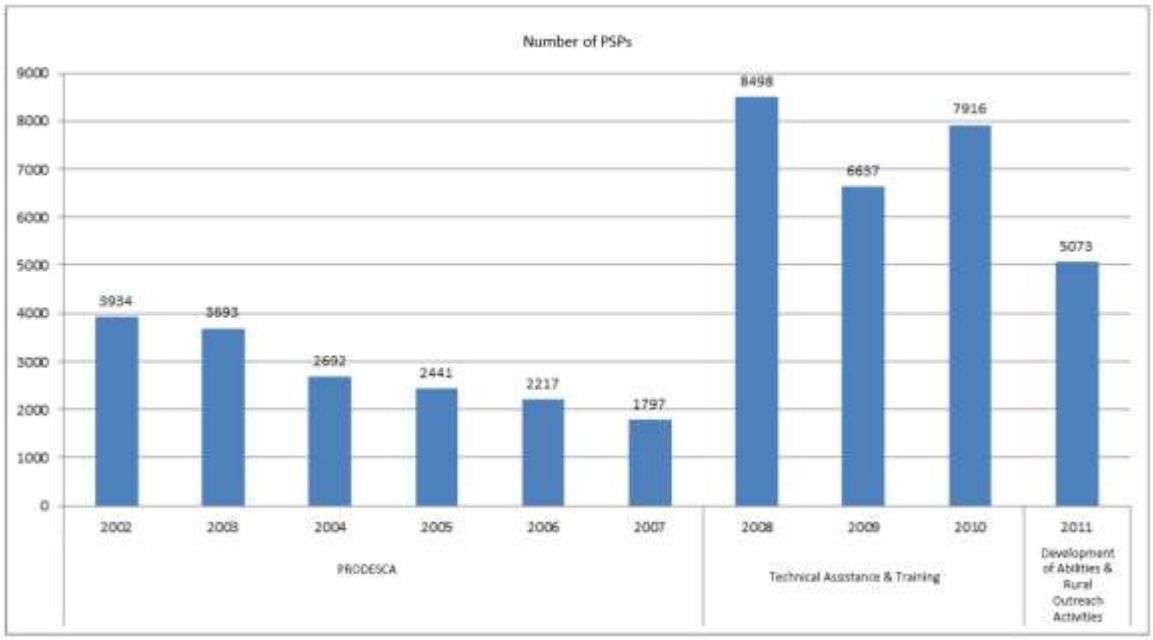
Source: Conacyt, SNI database, 2000-2010.

Table 23. Number of members of the SNI by institution, 2010 p/

Institution	Candidates	National Researcher				
		Level I	Level II	Level III	Total	%
National Autonomous University of Mexico	253	1,452	961	586	3,252	19.6
Public State Universities	1248	3,028	580	114	4,970	29.9
Research Centers – CONACYT	219	774	416	198	1,607	9.7
Center for Advanced Research and Studies	48	205	176	97	526	3.2
Metropolitan Autonomous University	68	428	198	69	763	4.6
National Health Institutes	88	362	75	49	574	3.5
National Polytechnic Institute	167	442	123	25	757	4.6
Private Universities	109	263	64	12	448	2.7
Mexican Social Security Institute	30	178	28	18	254	1.5
College of Postgraduates in Agricultural Sciences	31	114	58	19	222	1.3
National Institute of Forestry, Agricultural and Livestock Research	18	120	26	5	169	1.0
National Institute of Anthropology and History	5	57	43	10	115	0.7
Technological Institutes	113	210	47	15	385	2.3
National Institute of Nuclear Research	9	54	15	0	78	0.5
Electric Power Research Institute	7	32	5	1	45	0.3
Mexican Petroleum Institute	18	109	22	5	154	0.9
Private Companies	21	25	1	1	48	0.3
Foreign Institutions	57	50	1	0	108	0.7
Not specified	422	861	344	181	1,808	10.9
Others	107	180	27	3	317	1.9
Total	**3,038**	**8,944**	**3,210**	**1,408**	**16,600**	**100.0**

p/ Preliminary figures.
Source: Conacyt, SIN database SNI, 2010.

Figure 13. Innovation managers in agrarian and food sciences in relation to the Economically Active Population



Source: SAGARPA

Table 24. Seeded land area by federal state according to technical assistance

Agricultural year 2011 (hectares)

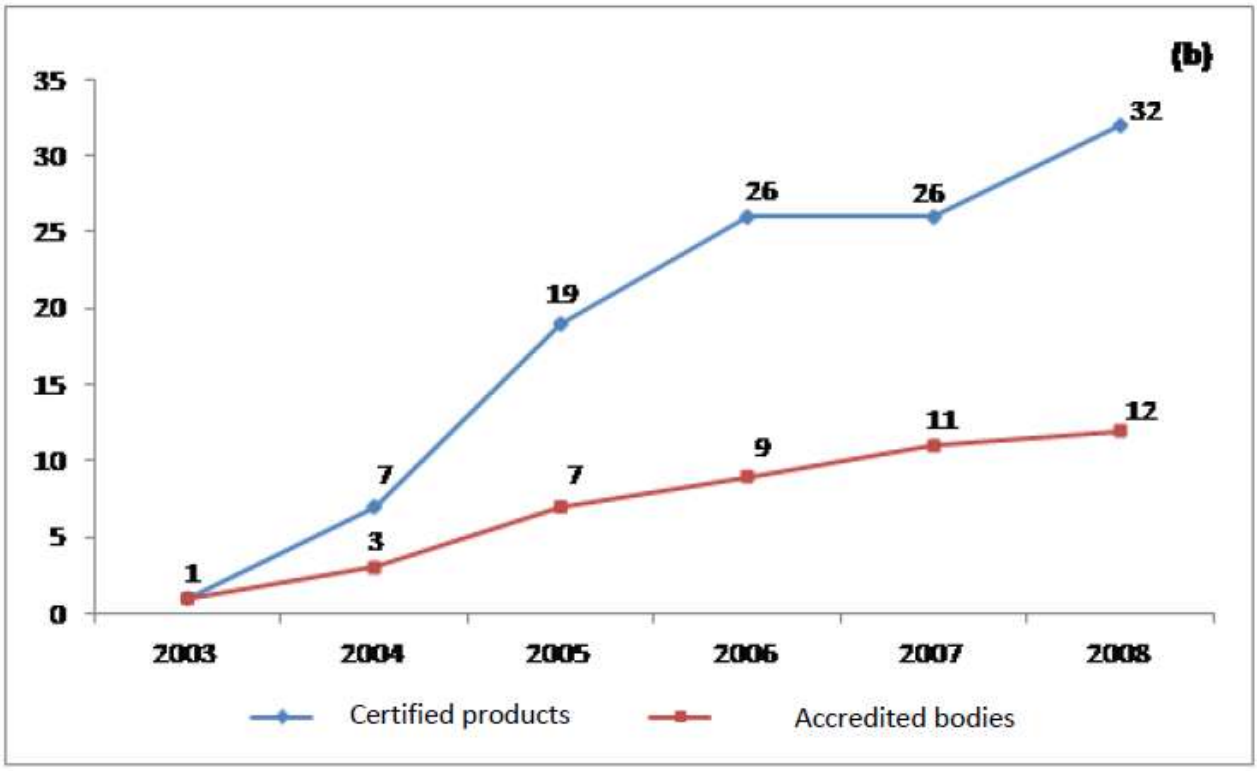
Federal State		Total	Seeded Land Area			
			With technical assistance		Without technical assistance	
			Absolute	Relative	Absolute	Relative
Estados Unidos Mexicanos		22,136,742	6,108,691	100	16,028,051	100
25	Sinaloa	1,626,551	1,466,755	24	159,796	1
28	Tamaulipas	1,477,137	620,820	10.2	856,317	5.3
26	Sonora	630,491	469,148	7.7	161,343	1
8	Chihuahua	1,031,680	450,764	7.4	580,915	3.6
30	Veracruz	1,456,305	404,808	6.6	1,051,498	6.6
16	Michoacán	1,081,740	404,117	6.6	677,623	4.2
24	San Luis Potosí	645,017	215,291	3.5	429,727	2.7
12	Guerrero	870,819	195,658	3.2	675,161	4.2
2	Baja California	225,138	184,323	3	40,815	0.3
15	México	872,271	182,914	3	689,356	4.3
20	Oaxaca	1,421,468	180,231	3	1,241,238	7.7
21	Puebla	1,011,921	150,815	2.5	861,106	5.4
10	Durango	695,285	149,100	2.4	546,184	3.4
14	Jalisco	1,592,094	123,013	2	1,469,080	9.2
32	Zacatecas	1,137,011	111,726	1.8	1,025,285	6.4
17	Morelos	134,072	108,015	1.8	26,057	0.2
5	Coahuila	291,237	99,725	1.6	191,511	1.2
7	Chiapas	1,449,954	72,915	1.2	1,377,039	8.6
18	Nayarit	402,677	67,955	1.1	334,722	2.1
22	Querétaro	169,082	66,071	1.1	103,011	0.6
13	Hidalgo	578,855	52,341	0.9	526,514	3.3
29	Tlaxcala	248,777	44,820	0.7	203,957	1.3
11	Guanajuato	1,074,542	43,496	0.7	1,031,045	6.4
6	Colima	158,368	40,998	0.7	117,370	0.7
27	Tabasco	239,904	40,895	0.7	199,009	1.2
3	Baja California S	40,711	37,633	0.6	3,079	0
31	Yucatán	778,297	34,403	0.6	743,895	4.6
1	Aguascalientes	122,812	31,281	0.5	91,531	0.6
23	Quintana Roo	115,541	30,518	0.5	85,023	0.5
4	Campeche	235,906	13,512	0.2	222,394	1.4
19	Nuevo León	299,953	13,266	0.2	286,688	1.8
9	Distrito Federal	21,127	1,364	0	19,763	0.1

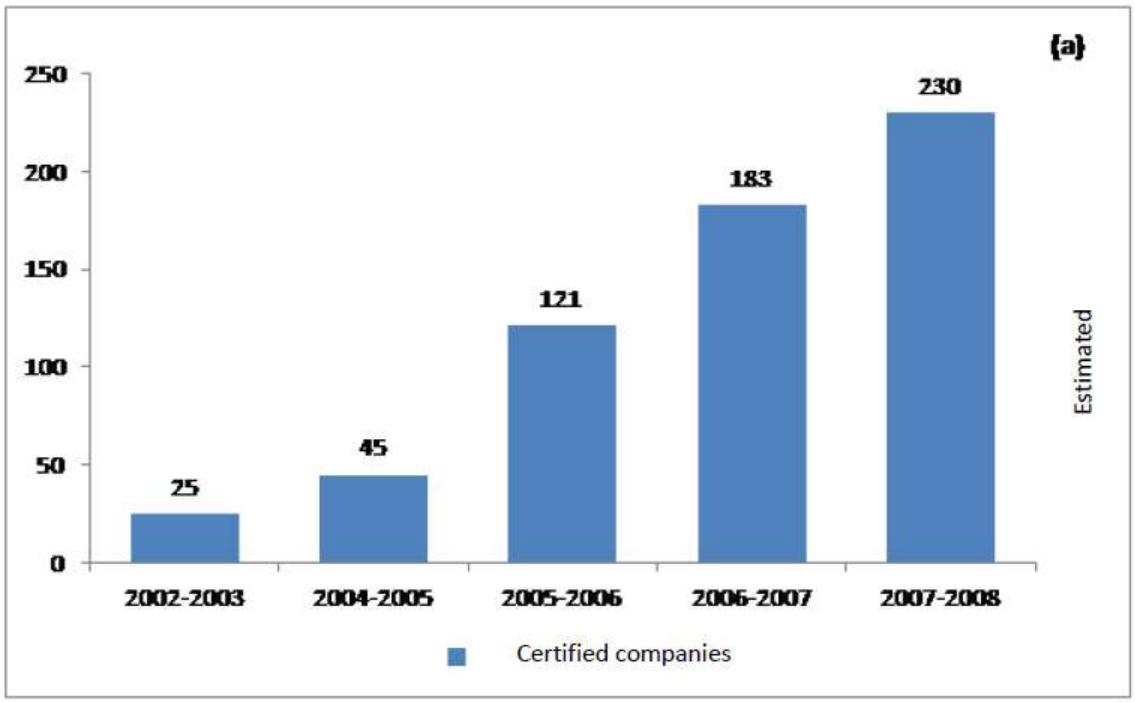
Note: The data are in order of highest to lowest according to seeded land area with technical assistance.

Source: Agri-food and Fishing Information Service (SIAP). Statistics on technology and services use on the agricultural land area. 2011 Tables

An alternative training and technology promotion mechanism is linked to agri-food product certifying bodies. According to figures from México Calidad Suprema, A.C., the volume of products differentiated by their certification has been increasing, starting from 490 tons in 2002 and reaching 1.9 million tons in 2007. Figure 14 shows the parallel growth in the number of certified companies, as well as the number of certifying bodies. These bodies are usually an effective vehicle to get technology to the producers and companies for products aimed at high value market niches. It is necessary to have a more active promotional policy to make sure that these instruments are better promoted and that more producers can access the benefits of selling their products at higher prices, provided they comply with the good practice procedures demanded.

Figure 14. Certified companies (a) and growth of products and accredited certifying bodies (b).





Source: México Calidad Suprema AC (MCS, A.C.) with information from certifying bodies[41]

Results of scientific and technological research and production

Technological change can strengthen, extend or replace natural comparative advantages for agricultural and livestock production and enable the country to:[42]

- Ensure sustainability of agriculture, in particular with regard to the equilibrium of ecosystems and the rational use of natural resources.
- Increase the productivity of agriculture and agroindustry by rationalizing the use of resources and maintaining or increasing production levels.
- Reduce unit costs for production, storage and distribution.
- Promote job creation and improve income distribution.

[41] This is a not-for-profit organization comprising producers, packers and their organizations with the objective of helping, along with the federal government, in the development and strengthening of the competitivity of the Mexican countryside through promotional, training and consulting activities, coordination of certification, and national and international promotion of the brand "México Calidad Suprema." http://www.aserca.gob.mx/artman/uploads/04-06--mexico-calidad-suprema.pdf

[42] Solleiro, J.L. and Pérez, G. (1996). Research, development and promotion of technology in agriculture and agroindustry in Mexico, in Del Valle and Solleiro (Coord.) The technological change in agriculture and agroindustries in Mexico, Siglo XXI Editores, Mexico, pp. 143-164

- Extend the frontiers of production in terms of changes to products and their production processes.
- Obtain and exploit the benefits created by research and development in other countries.

It is not an exaggeration to state that the ability to develop and manage technology under the physical, economic, social and cultural conditions of a country is the most important variable determining the differences in agricultural productivity between nations.[43] This is why a review of the scientific and technological activities necessary for innovation in the agri-food sector is fundamental.

According to its objectives, agricultural research is classified as basic, applied and adaptive.[44] Basic research is conventionally considered to be that which seeks to expand the basis of scientific knowledge without necessarily pursuing its application to solving some concrete problem. Applied research is directed at the use of knowledge to form a useful technological package for the production and distribution of a certain asset. Adaptive research aims to adapt technological innovations to specific production or market conditions.

Conversely, technological transfer activities comprise the agronomic and socio-economic validation of a certain technology, as well as technical assistance and outreach activities directed at their promotion and adoption by an extensive amount of producers.

Technical assistance refers to assistance given to producers by specialized technicians with a focus on the planning, administration, execution and evaluation of production processes and sales. Outreach is a wide-ranging concept comprising two large modalities: the first emphasizes educating and training producers and the second refers to the promotion and use of agri-food and forestry innovations. Given that the adoption and assimilation of innovations by producers is crucial for success, emphasis is placed on training activities comprising efforts aimed at improving individual and group knowledge, attitudes and skills in order to have a good command of specific technologies.

Most of the national agricultural research systems have been organized around the functions described.

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[43] Ruttan, V. (1992). Agriculture Research Policy, University of Minnesota Press, Estados Unidos.
[44] Polanco, A. (1990). The technology innovation process in Mexican agriculture, Cornell University, doctoral dissertation, Ithaca, New York

In the case of Mexico, formal agronomic research began in 1943, when the Office of Special Studies received strong scientific and financial support from the Rockefeller Foundation. The agricultural research system then adopted the US institutional model based on a system of experimental stations. The system's mission was to be a public convertor of internationally available technology to adapt it to local conditions.

This model evolved and the State took on a dominant role in the agricultural research system since it gradually developed the institutions that would fulfill the efforts of researchers in technologies for the sector. Thus, the National Agricultural Research Institute (now INIFAP) was created as a driver of the system by taking charge of research. In addition to the institute's work, other public and private agencies or institutions, including institutes specializing in specific crops, universities, public research centers, supplies producers, industry research laboratories, development and outreach services organizations form part of an ideal research assessment chain. We will analyze in detail the main players of the Mexican Agri-food Innovation System in the section corresponding to Axis 2.

With regard to the results of this research system, in the last decade Mexican scientific production in regard to the publication of articles in indexed journals with an international circulation has enjoyed sustained growth. In the case of agricultural research, this same trend is evidenced by the increase from 180 published articles in 2002 to 385 in 2009 (Table 25). For their part, publications related to "plants and animals" rose from 662 in 2002 to 1,470 in 2009.

This quantitative advance has not been accompanied by qualitative progress since references from these articles have been falling during the same period for both areas of the science (Table 26).

In any case, it can be said that **scientific performance in the area of agriculture has improved**. The same cannot, however, be said of the creation of patent protected inventions. If we include all technical fields, the index of technological dependence measured by the quotient of the number of patent applications from national inventors divided by the number of foreign applications barely reached 6.9 per cent in 2010 (Table 27).

With regard to agri-food sector related inventions, in the patent search we carried out by covering the classes most related to agricultural research results, barely 34

applications from Mexican inventors were identified in the period 2002-2011 (Table 28).

In the case of the protection application for new vegetable variety breeding rights, the figures for Mexican breeders are better since in the same period (2002-2011) a total of 273 applications were submitted in addition to the growing trend.

Despite this, we can conclude that **there is no high conversion rate of traditional scientific results** (2,534 articles published on agricultural research and 7,774 on "Plants and Animals" between 2002 and 2009) **into intellectual property susceptible to industry licensing** (a total of 34 patents and 273 breeding rights in the period 2002-2011). This is a demonstration of a generalized characteristic of Mexican research: being excessively oriented towards the generation of traditional scientific results as opposed to tangible impacts on the production apparatus.

Nor can we conclude that this intellectual property leads to new products being used by producers since there are no shared successful experiences of licensing these technologies to companies charged with the commercial production of products deriving from inventions and new varieties. As we shall outline in Axis 2, one problem of the system is the lack of effective technology transfer mechanisms resulting from research. On the one hand, there is insufficient experience and the attitude of research centers is passive [45] and on the other, supplies producers prefer to acquire proven technologies developed at their head offices in the case of multinationals or at proven technology and biological material supplier companies in other countries.

[45] On analyzing INIFAP activities reports, for example, the reference made to the transfer of new developed varieties technologies stands out since it limits itself to the assurance that "the material is available in experimental field X."

Table 25. Articles published by Mexican scientists by discipline

Discipline	2002	2003	2004	2005	2006	2007	2008	2009
Agriculture	180	282	274	341	329	341	402	385
Astrophysics	238	206	234	246	213	240	238	288
Molecular Biology	80	108	98	121	121	118	152	159
Biology	304	337	338	346	366	411	417	466
Social Sciences	140	155	149	171	187	219	356	420
Computing	50	122	226	192	197	79	87	107
Ecology	230	282	317	351	413	415	432	354
Economics	32	42	39	38	59	55	95	82
Pharmacology	76	104	101	157	127	134	141	168
Physics	920	946	846	1,024	919	985	1,122	1,054
Geosciences	179	234	233	261	270	244	339	371
Engineering	339	476	475	562	551	545	628	726
Immunology	57	62	79	85	89	99	105	116
Mathematics	186	180	179	242	217	245	254	273
Materials	287	278	315	337	418	388	326	492
Medicine	674	641	603	745	774	785	1,228	1,057
Microbiology	126	156	201	185	159	164	205	217
Multidisciplinary	3	2	5	4	2	2	12	18
Neurosciences	150	179	166	172	181	201	240	229
Plants & Animals	662	755	763	843	868	996	1,417	1,470
Psychology & Psychiatry	76	108	96	102	125	98	148	125
Chemistry	526	579	664	839	649	733	987	911
Total	**5,515**	**6,234**	**6,401**	**7,364**	**7,234**	**7,497**	**9,331**	**9,488**

The total number of articles from all disciplines does not coincide with the total due to the fact that there are articles categorized in more than one discipline

Source: *Institute for Scientific Information*, 2010

Table 26. References received according to the publication year of the article

Discipline	2002	2003	2004	2005	2006	2007	2008	2009
Agriculture	1,704	1,982	1,755	1,748	1,191	817	410	80
Astrophysics	3,495	3,014	3,257	3,042	2,292	1,524	1,116	279
Molecular Biology	1,652	1,998	1,461	1,209	954	881	503	104
Biology	3,709	3,971	3,449	3,374	2,542	1,964	1,018	190
Social Sciences	729	786	698	568	488	380	173	37
Computing	665	286	385	268	175	285	99	20
Ecology	3,297	3,132	3,590	2,868	2,702	1,635	717	131
Economics	115	331	137	160	144	78	35	11
Pharmacology	844	949	1,119	1,161	680	556	284	54
Physics	7,458	6,488	8,818	5,497	7,264	3,339	3,568	458
Geosciences	1,448	2,540	2,203	1,497	1,667	1,340	597	190
Engineering	2,236	2,128	2,323	1,958	1,393	1,063	432	123
Immunology	1,117	1,244	1,008	860	998	602	482	108
Mathematics	641	686	584	622	335	194	158	31
Materials	1,767	2,005	1,743	1,928	1,395	952	367	90
Medicine	9,933	8,200	6,868	8,518	6,577	5,027	2,653	687
Microbiology	2,695	2,271	2,598	1,917	1,174	702	365	90
Multidisciplinary	27	25	36	38	3	33	86	106
Neurosciences	2,172	2,641	2,013	1,932	1,459	1,058	677	102
Plants & Animals	5,418	5,379	4,678	3,649	3,265	2,130	1,447	293
Psychology & Psychiatry	336	745	274	426	197	280	157	26
Chemistry	5,952	5,849	5,441	5,815	3,294	2,783	1,780	359
Total	**57,410**	**56,650**	**54,438**	**49,055**	**40,189**	**27,623**	**17,124**	**3,569**

Source: *Institute for Scientific Information*, 2010

Table 27. Number of patents applied for and granted in Mexico, 1990 to 2010

Year	Applied For			Granted		
	Total	National	Foreign	Total	National	Foreign
1990	5 061	661	4 400	1 619	132	1 487
1991	5 271	564	4 707	1 360	129	1 231
1992	7 695	565	7 130	3 160	268	2 892
1993	8 212	553	7 659	6 183	343	5 840
1994	9 944	498	9 446	4 367	288	4 079
1995 a	5 393	432	4 961	3 538	148	3 390
1996	6 751	386	6 365	3 186	116	3 070
1997 b	10 531	420	10 111	3 944	112	3 832
1998	10 893	453	10 440	3 219	141	3 078
1999	12 110	455	11 655	3 899	120	3 779
2000	13 061	431	12 630	5 519	118	5 401
2001	13 566	534	13 032	5 479	118	5 361
2002	13 062	526	12 536	6 611	139	6 472
2003	12 207	468	11 739	6 008	121	5 887
2004	13 194	565	12 629	6 838	162	6 676
2005	14 436	584	13 852	8 098	131	7 967
2006	15 500	574	14 926	9 632	132	9 500
2007	16 599	641	15 958	9 957	199	9 758
2008	16 581	685	15 896	10 440	197	10 243
2009	14 281	822	13 459	9 629	213	9 416
2010	14 576	951	13 625	9 399	229	9 170

NOTE: A patent is usually granted years after its application
a From 1995, includes patents applied for through cooperation treaty
b From 1997, includes patents granted through cooperation treaty
SOURCE: For 1990-1992: Mexican Industrial property Institute (IMPI)
For 1993-2010: Mexican Industrial property Institute (IMPI)
Date of update: Thursday, February 23, 2012

Table 28. Patents in the agri-food sector

Year of publication	Applications registered in Mexico A01	Applications registered in Mexico by Mexican applicants	Mexican applications/ total	Areas approached by Mexican applicants					
2002	364	2	0.005494505	A01N 33/12	A01N 59/20				
2003	347	5	0.014409222	A01H 4/00 (2)	A01K 23/00	A01B 13/02	A01N 65/12		
2004	539	3	0.005565863	A01N 63/00	A01M 23/30	A01G 13/02			
2005	596	3	0.005033557	A01K 63/00	A01N 43/42	A01G 5/00			
2006	381	4	0.010498688	A01N 63/04	A01D 46/00	A01N 37/02	A01G 13/02		
2007	247	6	0.024291498	C12N 9/64	A01K 67/033	C02F 1/00	A01C 7/04	A01N 1/02	A01N 65/26
2008	850	5	0.005882353	C07K 14/325	A01N 65/08	C05G 3/00	A01N 63/04	A23K 1/16	
2009	644	0	0						
2010	591	4	0.00676819	A01G 25/00	A01B 13/08	A01K 13/00	A01M 1/20		
2011	442	2	0.004524887	A01K 13/00	A01J 25/00				
2012	0								

Sección A:		Current life needs Rural Activities AO1 Agriculture, forestry, hunting, fishing, breeding, capturing
	A01B	**LAND WORK IN AGRICULTURE OR IN**
A01B 13/02		Ploughs or similar machines for special jobs to mulch, that is to say, with symmetrical moldboards (millers)
A01B 13/08		Ploughs or similar machines for special jobs to work on the subsoil
	A01C	**PLANTING, SEEDING, FERTILIZATION**
A01C 7/04		Isolated grain seeders with or without suction devices
	A01D	**HARVESTING AND CUTTING**
A01D 46/00		Harvesting of flowers, vegetables, hops or similar products; devices to shake trees or bushes
	A01G	**HORTICULTURE; GROWING OF LEGUMES, FLOWERS, RICE, FRUIT, GRAPES, HOPS OR KELP; FORESTRY, WATERING**
A01G 5/00		Flower manipulation
A01G 13/02		Protective covers for plant; devices to place plant
A01G 25/00		Watering of gardens, fields, sports field or similar
	A01H	**NEW VEGETABLE ADDITIONS OR PROCEDURES TO OBTAIN THEM; PLANT REPRODUCTION FOR TISSUE GROWING TECHNIQUES**
A01H 4/00 (2)		Plant reproduction for tissue growing
	A01J	**MANUFACTURE OF DAIRY PRODUCTS**

Source: IMPI in figures, 2010.

Table 29. Number of applictions submitted per year according to nationality

Nationality/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
German	10		3			8	11	1	5		38
American-Mexican				2							2
Australian							1	3		3	7
Australian/German							3	1	2		6
Belgian						2					2
Canadian	1										1
Czech									1	2	3
Colombian									4		4
Spanish		2					1		4	4	11
US	15	21	14	15	42	42	60	49	28	44	330
French	3	5	8	2	3	3	4	5			33
Guatemalan				1							1
Dutch	1	1	1	8	22	28	44	23	22	18	168
Dutch-French					1		2				3
Honduran			1								1
English				2			3		1		6
Israeli			5			2	5		2	4	18
Italian						6	1	6		2	15
Japanese						1					1
Mexican	13	4	13	7	19	20	43	67	27	60	273
New Zealander		1					2		3	5	11
Panaman							1				1
South African			1	1						2	4
Swedish							1				1
Swiss									1	1	2
Total	43	34	46	38	87	112	182	155	100	145	942

Source: National Seed Inspection and Certification Service.
Book of Applications for the Title of Breeder. Period 2002-2011

Summary of the science, technology and innovation dimension

- Mexico's scientific capacity is small in relation to the size of its economy, number of inhabitants and the social and competition challenges that must be faced.
- Investment in science, technology and innovation is very low, even compared to that of countries in intermediate development. In the case of the agri-food sector, the resources dedicated to this kind of activity are even less and subject to large fluctuations.
- Depite the limitations, the number of researchers and graduated doctors in disciplines relevant to innovation in the agri-food sector has been increasing, thereby establishing a favorable basis for the development of research in the sector.
- However, the predominant direction of research is determined by the evaluation systems of the performance of researchers, who place emphasis on the publication of scientific articles and the education of human resources. The solution to problems and the transfer of technology play a subordinate role.
- There is little institutional experience in technology transfer, which, togeher with the marked academic direction of researchers, causes there to be a weak translation of research results into useful technologies and a solution to problems.
- The PSPs, which should play the role of innovation managers by contributing to the promotion and adoption of technologies on the part of producers must repond to the excessive expectations of public policy designers and operators (strategic planning, project formulation, access to public resources, technical consulting, trade strategies and training), which dilutes their performance and inhibits their role as innovation promotors, a situation which is made worse by instability in their payments and the absence of an incentive scheme for good performance.
- Therefore, it can be said that Mexico has a more of a reserach system than an innovation system.

Conclusions of Axis 1

Starting from this analysis of SNIA indicators, according to Axis 1 of the Guide, we can confirm that the Mexican agri-food sector is heterogeneous from different perspectives. There are very successful export products with a growing presence in international markets, such as tomato, vegetables, organic products, chilis, beer and tequila, but also increasing imports of basic products for food and agroindustrial processing. Large regional differences can also be observed since states like Sinaloa, Sonora and Tamaulipas have much greater access to subsidies, infrastructure, technification, specialist supplies and technical assistance. All this contributes not only to marked differentials in agri-food productivity and profit, but also to making the differences between producrs more acute.

Mexico has a persistently high percentage of rural poverty due to the number of subsistence producers working on low quality land with little access to technology enabling them to modernize operations and increase yields.

There is a section of analysists and decision makers in the agri-food sector who think that there is an "overpopulation" of the sector and that it should be rationalized by offering opportunities to those persons who make a living from agriculture so that they can diversify their sources of income by emphasizing employment outside of the sector. This is a way of sidestepping the central problem, which is how to make agri-food production dynamic and more competitive.

Producers require better access to supplies, technification, financing, technology and training. It is also important to nominally increase investment in basic infrastructure for irrigation, transportation and storage since these are still insufficient and inadequate.

Another feature of the agri-food system is that, despite efforts to integrate so-called product systems, agroindustrial value chains are disparate and, on many occasions, the real producers do not feel represented by these bodies. Problems such as the lack of reliability and quality of supplies make very successful industries resort to imports or to large local suppliers to obtain their supplies without any effort being made to develop small suppliers, which would generate market incentives to improve production.

In regard to technological innovations, these are systematically incorpoated by commercial agriculture producers, who resort to technolgical resources in other countries and also receive technical support from said countries and from machinery, agrochemicals and seeds suppliers. There are some small producers

who work by contract for produce export vegetables and who access technological packages supplied by sales companes acting as intermediaries. In both cases, links with institutions' technological offers are very scarce.

Mexican agricultural research has gone down a very academic route. The indicators are revealing of this situation since while production of scientific articles has solidly increased in the last ten years, the generation of intellectual property and effective technological solutions for producers represents a very small percenage of research results.

This is the consequence of an incentive system for researchers which emphasizes academic production and sidesteps problems in the sector. More technologies are now urgently needed for the efficient use of water to improve land, correct pollution problems, increase production yield and improve comprehensive farms management.

The agri-food innovation system presents serious structural problems, which must be urgently addressed. One of the main problems is undoubtedly insufficient resources since the investment level in innovation activities in Mexico is very low from any point of analysis. Moreover, the system is fragmented due to the academic orientation already mentioned and the manifest disinterest of agroindustrial companies and producers in linking up with research institiutions.

Furthermore, technology and training transfer mechanisms, as shall be explained in detail in the next section of this study, have a small reach in relation to the size of the problems in the sector.

Under current conditions, the main challenges of Mexico's production systems are:

- Reduce rural poverty because 40 per cent of producers live below the poverty line with no access to finance, supplies or technology.
- Reduce differences in productivity between producers and different sized companies.
- Create high quality jobs which consolidate activity within the sector.
- Strengthen policies to exploit market niches for certified products.
- Increase local production because imports of basic products are growing, which represents a significant outflow of foreign currency, and sufficient food stocks are being compromised
- Increase efficiency in the use of water and crop yields.

- Reduce pollution caused by agricultural and livestock exploitation, as well as soil salinity and erosion.
- Improve producers' access to relevant raining.
- Substantially increase integration between the knowledge offer and demand for the sector in order to offer effective solutions to sector problems and have a favorable impact on their productivity.
- Connect the innovation system through clear collaboration incentives between knowledge sellers, supplies and machinery producers, agroindustrial companies and producer organizations.

CONCEPT 2: CHARACTERIZATION OF SYSTEM AGENTS AND NETWORKS

INTRODUCTION

In this section, we characterize the main agents in the system, their dynamics and their roles in the innovation process. In accordance with the National Innovation System for Food and Agriculture (*SNIA*) assessment guide, this characterization seeks to answer the following questions:

- Which public and private agents are involved in the effective innovation in national agrifood systems (not only those involved in research, but also those who are actually responsible for incorporating knowledge and ownership of the resulting value of this incorporation of knowledge)?
- How do the participants interact and how do they determine the innovation in *SNIA*s (who are the dominant agents that determine the system's modernizing movement and innovation dynamics)?
- Which agents are most capable of generating and appropriating value in the *SNIA*?

- In summary: how can we describe the participation of agents in the systems in terms of their ability to manage the innovation process, and what are the strengths and weaknesses of these agents?

The basic structure of the description of participants and networks is presented in two parts: (I) description of the role of each participant group of the *SNIA*, and (II) description of systemic interactions of these groups.

For Mexico, this characterization was performed by first consulting official documents on the functions assigned to each of the main agents, as well as reports and various studies presenting timely assessments of institutions, specific programs or the national agrifood innovation system as a whole. Secondly, a workshop was held at the Autonomous University of Chapingo (*Universidad Autónoma Chapingo*), the purpose of which was to listen to the views of different agents from the academic, government and private sectors regarding the performance and interaction of those involved in *SNIA*s (see list of participants in the Appendix 1). With the information collected, an analysis of social networks was conducted to identify the strength of working partnerships between agents. Lastly, we obtained a valuable addition to the qualitative analysis of strengths and weaknesses by directly interviewing officials in key positions in institutional circles (see Appendix 2).

Characterization of the role of the main agents in the *SNIA*

It is clear that the National Innovation System for Food and Agriculture transcends this conception of a research system; an innovation system for food and agriculture includes both participants of the supply chain (suppliers, producers, agro-industrial processors, distributors, exporters) and government workers and those involved with universities, research institutes, outreach and development agencies, etc. Policies, legal frameworks and attitudes that encourage and guide knowledge incorporation processes, technology and value-added production also complement the concept. An innovation system can be defined as a network of organizations, enterprises and individuals focused on giving economic use to new products, processes, organizations or a combination of all three, together with the institutions and policies that affect their behavior and performance.[46] Farmers' ability to innovate will depend on the degree to which they are linked with the other participants in the value chain, and how well knowledge sharing is organized throughout the chain.[47]

[46] Swanson, B.E. *Global Review of Good Agricultural Extension and Advisory Practices*, *FAO*, Rome, 2008

[47] Innovation systems are much broader than research ones, because in a research system only research institutions participate. Innovation adoption is a creative and interactive process that involves institutions that participate in markets and others that do not. What's more, innovations depend even more on effective

In accordance with the guide, we will address the participant analysis by looking at the main groups.

Goods suppliers

This category of agents is of great importance within the *SNIA* because goods suppliers are often the main vehicles of embodied technology transfer (to biological material or machinery), and because the supply of products is usually accompanied by technical assistance and training for producers who are the customers of the companies.

We will synthetically analyze the roles of different goods suppliers:

- *Animal genetics suppliers: breeding stock, embryos and semen*

For animal production systems to develop and be sustainable it is necessary to know and have comprehensive and systematic information about animal genetic resources (AGR) in their current and potential use. To cite Mexico as an example, in over 50% of the country livestock is the most important primary activity and meets many livelihood needs, sources of income and must represent food security. However, by tradition, and because of environmental and economic conditions, the way livestock are raised and handled is highly variable, resulting in varying levels of production and productivity where we can see backyard systems and large consortia, with either no or large capital investment in the use of front-line livestock technologies, as well as AGRs not in complete harmony with the production environment. This means there are few suppliers with local R&D capacity; some of the most advanced genetics laboratories are joined to leading producer groups, and therefore do not put their products on the open market.

In Mexico, breeding has been based on the migration of animals and genes from bred populations by importing germoplasms from developed countries. Given the economic importance of livestock, there are a number of supply companies that provide goods for breeding. However, for most productive species the structure is pyramidal, so a relatively low number of producers (farmers) at the top sell elite breeding stock to a higher number of farmers who act as multipliers, then selling animals to a large amount of commercial breeders, who are the final recipients and are located at the base of the

interaction between a country's scientific basis and its business community

pyramid.[48]

- *Production of plant genetics: the seed industry*

In Mexico there is a private seed industry dominated by multinational companies engaged in research, mainly at the laboratories of their parent companies and that have facilities in Mexico for acclimatization and adaptation of materials for different parts of the country. The Mexican Seed Trade Association (*Asociación Mexicana de Semilleros, A.C.; AMSAC*) has 51 member companies that provide seeds for the main commercial crops. It is worth mentioning that Mexican companies are mainly importers and distributors of seeds and only some of them have facilities for multiplication programs.

While no research is done locally, Mexican seed companies do play an important part in the process of technology transfer as they invest in demonstration plots, training programs and technical support for producers.

- *Agrochemicals producers*

As is the case of the seed industry, in Mexico there is a well-established industry that produces and distributes agrochemicals. Large multinational consortia with the biggest market share dominate it, although there are also large Mexican firms that produce generic herbicides, insecticides and fungicides. Other smaller companies are involved in the distribution.

Member companies of the Mexican Association of Phytosanitary Industry (*Asociación Mexicana de la Industria Fitosanitaria, A.C.; AMIFAC*) cover 70% of the market. In addition to their role as suppliers of innovative products based on foreign technology, these companies provide technical support and training to their customers not only in the production aspects in relation to the use of their products, but also on the safe and sustainable use of agrochemicals. They provide information support and consultancy in the event of agrochemical poisoning, and assistance for the adoption of good practice in the use, handling and transportation of products, as well as packaging disposal.

- *Biological products*

The case of bio-fertilizers and bio-pesticides is particularly interesting because it is an area where Mexican investors have emerged, often linked with research centers and

[48] Animal production and breeding. Summary of course notes from the Animal Reproduction module, Department of Reproduction and Breeding, Faculty of Veterinary Medicine and Zootechnics, Autonomous University of Yucatán (*Universidad Autónoma de Yucatán; UADY*), Mérida, Mexico

universities, developing new businesses. Most of these businesses are small and new, although they are gradually establishing themselves in the market. Their strength is managing their own technology, their flexibility and their relationships with academic centers and specific market niches. Their weakness lies in the lack of resources to undertake multinational industry actions, such as demonstration events, deployment of outreach agents to advise producers and the provision of technical support to a large number of producers.

- *Equipment for the generation of alternative energy*

There are suppliers of equipment for solar generation and bio-digesters, generally for low-scale production. The solar cells are gaining acceptance to support production in greenhouses. The bio-digesters have also gained acceptance from livestock farms for manure management, with the benefit of gas generation.

This is still an emerging industry that has its own manufacturing capabilities. Its development depends on electricity and fuel subsidies that become a competitive element, creating an obstacle for these innovative systems.

- *ICT applied to the food and agricultural sector*

In this case, there is a wide range of customized solutions, given the proliferation of software factories, small businesses and independent programmers who interact in the market with large foreign and domestic companies that have significant capacity. Applications being developed include process control devices, logistics management (loading, storage, transportation and billing) and applications for mobile devices.

- *Specialized technical services networks*

In Mexico, as already seen in Concept 1, the rural extension scheme is now based on recorded professional service providers who provide a wide range of services. Their effectiveness is analyzed later on, when the government agency responsible for its management appears.

- *Animal health*

In Mexico there is a wide range of goods suppliers for animal health and nutrition including large multinational veterinary medicine companies that produce and distribute products developed at their parent companies, and local companies that produce vaccines, serums, probiotics and generic drugs. There are a small number of Mexican companies with investments in R&D and relationships with research institutes that have had remarkable success in the development and commercialization of new products.

There is a government-owned corporation, the National Producer of Veterinary Biologics (*PRONABIVE*), that creates, develops and markets animal health products, particularly vaccines and bacterins; drugs to prevent mastitis drugs, mites, bee varroa, hematophagous bat control balm, diagnostic reactives; and syringes and diagnostic kits. It also assembles products or certain operations within the industry such as lyophilization. Its processes are certified.

- *Agricultural machinery and equipment*

Mexico has a large agricultural machinery industry, and the most important multinational companies have production plants. John Deere, AGCO and CNH manufacture in Mexico (mainly medium-sized tractors) to supply the local market and to export to other countries in Latin America, the United States and other countries. International trade is growing (see Figure 1).

Dependence on imports is marked with regard to harvesters and sowers. The implements sector has an important participation of small local producers that supply the domestic market. In this area there are some local design activities and some companies have begun to collaborate with engineering research centers such as *CIATEQ* and the Center for Engineering and Industrial Development (*CIDESI*).

As stated by Donoso,[49] the competitive edge of this industry is summarized as follows:

- The effect of the free trade area has allowed access to the huge markets of the US and Canada and attracted major international players, enabling the industry to enter international trade in production scale and competitive technology.
- Mexico's participation in international trade has been established on the basis of a model of specialization in the medium scale of products, particularly in tractors.
- The degree of industry integration is intermediate (around 50%), with its own production of parts, with manufacture based on local goods and imports of higher value-added components (engines, transmissions, drivelines), which are directly assembled.
- Mexico has important competitive advantages such as a skilled, low-cost workforce, excellent road and port infrastructure, and access to basic goods like steel in satisfactory qualities.
- For Mexican industry the opening of markets also creates a growing threat posed by Chinese imports in unfair trade conditions. Although these imports are not yet of material importance, the absence of precautionary policies is of concern

[49] Donoso, J. The Agricultural Machinery situation in Latin America, STRAT Consulting, Rosario, Argentina, 2007

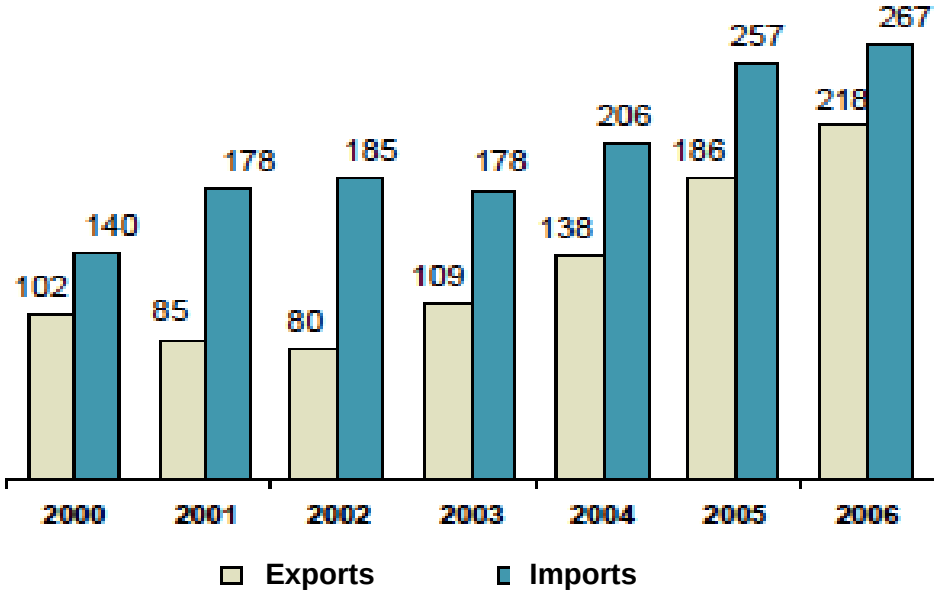
to the industry.

- As in other markets, the sowing and agricultural implements segment has more local features, with medium-sized manufacturers that also export and import, but without the participation of the major brands.

Figure 1

Development of Mexican agricultural machinery imports and exports (2000-2006)

Amounts in US$ millions



Source: Donoso, J. The Agricultural Machinery situation in Latin America, STRAT Consulting, Rosario, Argentina, 2007

Processing industry and trade

- *Food and beverage industry*

The Mexican domestic market is sufficiently attractive to the presence of very important national and multinational processing companies. Along with the major international players, domestic companies that export products and capital to many countries compete in the market. Companies such as *Grupo Modelo*, *Bimbo*, *Maseca*, *FEMSA* and alcoholic drinks manufacturers have become global companies. These companies have invested heavily in innovation, mainly acquiring global equipment supplier technology and process technologies. All have R&D departments at their disposal for product innovations for different market segments, and some have technological partnerships

with research institutes.[50]

At the same time, there are thousands of micro, small and medium enterprises distributed all around the country, supplying the local market. There is great diversity in terms of technological sophistication. There is currently a phenomenon of impetus on traditional Mexican products that are exported to the United States and other countries; this involves the challenge of obtaining quality certifications, so the export industry is making small investments in R&D and establishing involvement with research institutes.

- *Process industries for other agricultural products*

In Mexico there are several industries that use agricultural goods such as industries for cotton fiber, wood and furniture, leather and footwear, paper, tobacco, alcohol and biofuels, to name a few. These industries often follow traditional technology strategies, incorporating their innovations by purchasing equipment and they make little investment in R&D. They have little connection with technology centers and universities.

- *Purchasing and marketing agents*

Mexico has important structures to facilitate logistics mainly associated with the foreign food and agriculture trade. This means that it has the infrastructure for the collection, storage, transportation and distribution of products, with a strong emphasis on fruit and vegetable exports and on grains and oilseeds imports. Large global consortia such as Cargill and ADM have a dominant presence in the country.

For domestic trade, infrastructure and investment are not so big. This results in significant logistics costs, so there are now organizations oriented towards facilitating the movement and distribution of products, the idea being to improve trade conditions for producers. These associations have little interaction with the innovation system.

- *Food industry agents*

The size of the Mexican market is attractive enough to have the most diverse investments in this segment. There are well-established companies offering distribution services to consumers (supermarkets and convenience stores, catering companies, restaurant chains, bakeries, gourmet shops, organic food shops, etc.). Here, we see the combination of the presence of large global consortia (Walmart has a clear dominance of the market) and national companies of various sizes. In this link with the industry, Mexico's culinary culture plays a key role, meaning advantages for companies making

[50] There have been successful cases such as the brewing industry's collaboration with *INIFAP*. This institute has recently taken part in technology projects with global companies like Bimbo

differentiation efforts by offering high-value products, with strong roots in tradition.

R&D and dissemination agents

- *Public research organizations*

There are several public food and agriculture research organizations in Mexico. The main groups are managed by The Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*SAGARPA*), so they stick to their policy guidelines. Here we will mention the main ones:

National Forestry, Agriculture and Livestock Research Institute of Mexico (*INIFAP*)

INIFAP is the main executing agency within the institutional agreement for research and technology transfer. Its objectives are:

- To generate knowledge and technological innovations that contribute to the sustainable development of Mexico's forestry, agriculture and livestock industry chains.
- To develop and promote strategic and frontier research to contribute in a timely manner to the solution of the big problems of productivity, competitiveness, sustainability and equity of Mexico's forestry, agriculture and livestock sectors.
- To promote and support forestry, agriculture and livestock knowledge and technology transfer, in accordance with the priority needs and demands of producers and society; and to contribute to the formation of human resources.
- To strengthen institutional capacity through training, renewal and motivation of its staff, as well as the modernization of infrastructure, procedures and management to meet the demands of society.

The active staff of *INIFAP*, in their totality, are distributed as follows:

Type of staff	**Number**	**%**
Scientific	884	46
Staff in positions of trust	128	8
Permanent staff	725	37
Middle and senior managers	164	9
Total	**1901**	**100**

INIFAP is nationwide in Mexico, with research facilities and experimental fields around the country, and manages research and innovation networks in the following areas: sustainable forest management, environmental services, annual oilseed harvests,

perennial industrial crops, water and soils, vegetables, pastures and forage resources, deciduous and tropical fruit trees, maize, plant health, beans and other leguminous plants, wheat and other small grains, bioenergy, agroforestry plantations and systems, beef, biotechnology, mechanization and instrumentation, pigs, bovine milk, modeling, honey bees, and animal health.

INIFAP has clear strengths in research, but while it has experience in collaborating with companies and producers, its approach to technology transfer is somewhat passive: this is evident in its earnings release where, when referring to transfer, it mentions that its technologies are available in different fields (in the hope that there will be interest).

Despite its experience in handling networks, specialists who were interviewed agree that it is very difficult to establish collaboration and coordination between different research institutions, so *INIFAP* fails to exploit the potential of inter-institutional collaboration.

Graduate College

The Graduate College is a public institution and its fundamental activities are education, research and liaison. On the basis of these three activities and the need for management that will allow the activities to be performed effectively, the following strategic objectives were defined:

1. To educate and train creative, innovative and humane-minded individuals to address society's food and agriculture needs in a context of sustainable development.
2. To conduct research that will generate relevant knowledge for the sustainable management of natural resources, and for the production of nutritious and safe foods as well as other goods and services.
3. To improve the quality of life in society and feed back academic activities through liaison.
4. To have certified management processes to support the institution's core activities effectively and efficiently.

As can be seen, there is an explicit liaison objective, but the College does not have a solid structure for technology transfer, which has created the perception that it is geared towards traditional, academic-style activities.

National Fisheries Institute (*INAPESCA*)

In August 1962 the National Institute of Fisheries Biology Research (*INIBP*) was established, aimed at fisheries research. At the time it contributed basic knowledge on biology, distribution and abundance of marine and freshwater resources in Mexico.

From 1971 it became the National Fisheries Institute (*INP*), to incorporate new areas of research aimed at the assessment and management of resources and comprehensive analysis of the fishery system. It made connections with the production structure within the sector, strengthening its government advisory role for the suitable management and planning of fisheries and aquatic development in Mexico. In 2007, the Institute celebrated its 45th anniversary and was revitalized with a new legal framework.

Today, *INAPESCA* is a decentralized body of *SAGARPA*. Its mission is to coordinate and conduct scientific and technological research on fisheries and aquaculture, as well as on any development, innovation and technology transfer required by the fisheries and aquaculture sector.

The National Fisheries Institute is the only Mexican fisheries and aquaculture research institute with nationwide coverage and in permanent contact with the fisheries and aquaculture sector, as well as its development and administration problems. It has 14 research centers.

The work carried out as part of the principle of responsible fishing provides the fishery and aquaculture authority with scientific basis, with reliable data in order to conserve, arrange and develop fishing and to contribute to the protection of biodiversity, ecosystems and aquatic habitats.

- *Other executing research institutions*

Although *INIFAP* is the main public agricultural research institute both in terms of budget and personnel, other government organizations were identified that conduct research and development (R&D) in the agricultural sector in Mexico. These include the Research Center for Food and Development (*CIAD*), the Mexican Institute of Water Technology (*IMTA*), the Yucatán Center for Scientific Research (*CICY*) and the Center for Research and Applied Technology in Jalisco (*CIATEJ*), among others. There are centers that have machinery and equipment design capabilities that have had experiences in the development of projects for manufacturers of agricultural machinery and implements.

Universities play a key role in agricultural research and their participation has increased from 26% in 1981 to 54% in 2006 (measured by the number of researchers), while the participation of government institutions has decreased. While the Autonomous University of Chapingo, the Graduate College and the Antonio Narro Agrarian

Autonomous University (*UAAAN*) are the main universities, making up 22.5% of the total budget, the rest is divided among a large number of higher education institutions.[51]

Sustainable Modernization of Traditional Agriculture (*MasAgro*)

MasAgro is an effort headed by Mexico, together with the International Maize and Wheat Improvement Center (*CIMMYT*), to strengthen food security through research and development, capacity building and technology transfer to the field so that small- and medium-scale maize and wheat producers have high and stable yields, increase their income and help mitigate the effects of climate change in Mexico. Its objective is to sustainably increase the productivity of maize and wheat in rain-fed areas over a ten-year period, from 2010 to 2020. This is a new initiative of which the results and impacts must be assessed in the medium term.

MasAgro has four interrelated components that address the priorities for research and development of productive capacities in the short, medium and long term. The purpose of this is to boost food security, economic development, adaptation to climate change and environmental sustainability through collaborative projects with the most disadvantaged farmers, emerging entrepreneurs and with other developing countries in general.

The *Discovering the Genetic Diversity of Seeds* component seeks highly specialized resources and infrastructure to allow Mexico's scientific community to study and take advantage of the genetic diversity of maize and wheat in breeding programs for both crops.

The *International Strategy to Raise Maize Yield* is responsible for improving the adaptability of maize to adverse conditions and boosting productivity of the Mexican seed industry, in order to increase, in a sustainable way, the production of small- and medium-scale farmers in rain-fed areas.

The *International Strategy to Raise Wheat Yield* coordinates complementary research in 30 countries with the goal of increasing the grain yield potential by 50% over the next 20 years by improving highly productive varieties adapted to the wheat regions of Mexico and the world.

The *Sustainable Development with the Producer* component is a rural outreach strategy based on collaborative networks, enabling the adoption of sustainable agricultural

[51] Deschamps, L. Mexican Innovation System of Food and Agriculture, Inter-American Institute for Cooperation on Agriculture, work document, Mexico, 2012

practices, technology transfer and the use of improved seeds for maize, wheat and related crops that, together, increase productivity and farmer incomes in a sustainable way.

Technology transfer agents and organizations

- **General Directorate of Capacity Building and Rural Outreach**

In the area of research and outreach work, the Rural Sustainable Development Law delegates its implementation to *SAGARPA*, which coordinates the various executive bodies whose tasks include agricultural research, technology generation, experimentation and outreach work. To that end, this Law provides for the establishment of the following federal institutions or entities: the National Research and Technology Transfer System for Rural Sustainable Development (*SNITT*), Product System Committees, and the National Rural Training and Technical Assistance System (*SINACATRI*). *SNITT* is responsible for coordinating the activities of both the public and private sectors in scientific agricultural research, technology development and knowledge transfer, while *SINACATRI* is responsible for training and technology transfer. *SNITT* is answerable to the Subsecretariat of Agriculture, and *SINACATRI* to the Subsecretariat of Rural Development.

The General Directorate of Capacity Building and Rural Outreach at *SAGARPA* has the following responsibilities:

> I. Develops, proposes and implements, where appropriate, in coordination with the relevant administrative units and decentralized bodies at the Secretariat, strategies for the development of productive, organizational, financial, commercial and management capacities for farmers through education, training, technical support and outreach services, to facilitate access to knowledge, training and technology in all areas of plant and animal production.
> II. Participates in the development of policy development for skills, technical support and outreach, and proposes the criteria and tools for capacity building, technical support and outreach for the National Rural Training and Technical Assistance Service.
> III. Supports the National Rural Training and Technical Assistance Service in establishing procedures for the assessment and registration of available technical services offered by service providers, both individuals and businesses, as well as by research and middle and higher education institutes, with technical services available to producers.
> IV. Issues, with the participation of other relevant administrative units and decentralized bodies at the Secretariat, the criteria for training, accreditation

and certification for those providing technical support, training and outreach to help farmers.

V. Promotes, within the area of competency of the Secretariat, schemes for collaboration with research and higher education institutions, to define services of research, technology development, education and training for rural sustainable development.

VI. Establishes, with the participation of the Secretariat's administrative units, the operational criteria for technical, organizational and managerial liaison with social and private institutions and organizations.

VII. Proposes and promotes strategies for the participation of family agriculture producers in fairs, events and exhibitions.

VIII. Promotes, in collaboration with other relevant administrative units and decentralized bodies that belong to the Secretariat, technical support and training related to agriculture and food production projects, taking into consideration ways of organization, rural enterprise development, infrastructure, market research and rural finance.

IX. Promotes technical services for economic production activities and quality of food products produced by rural families.

- **National Rural Training and Technical Assistance System (*SINACATRI*)**

In the new context of agricultural policy in Rural Sustainable Development Law, the Integrated Rural Training Policy proposed to "move from supporting the provision of technical training for producers, to the development of human capital in the rural sector to allow the expression of all the creative potential of those living in the countryside, as well as moving away from passive participation of members of society in order to actually strengthen it as a way of involving people in decisions that affect them".

This involves moving **from a conception that focuses exclusively on encouraging production, to one that includes the arranging of markets, multidimensional promotion of rural employment and conservation and enhancement of natural resources**, from a territorial point that sees rural society as a whole as the central subject of development.

The rationale for this new approach sought to "overcome the reductionist approach that addresses training only to meet the requirements of agricultural and forestry producers, and to replace it with a vision that supports different wealth generation activities and contributes to economic, environmental, human and social development in the rural sector".[52]

[52] Integrated Rural Training Policy, p. 23, National Rural Training and Technical Assistance System, Mexico. *SINACATRI*, 2004

SINACATRI is an essential tool of the new rural development planning system created by the Rural Sustainable Development Law, by which it seeks to unify the actions and resources of the three levels of government and the sectors involving education, training, consultancy and technical support for rural development.

The general policy of *SINACATRI* adopts a **comprehensive approach** that, from a regional perspective, focuses on the development of human capital and, as a result of its actions, on other strategic areas of rural sustainable development: economic capital development, social capital development and physical capital development.

SINACATRI operates through a service, the **National Rural Training and Technical Assistance Service (*SENACATRI*)**, whose main functions are to direct, plan and implement integral rural training and technical support activities; and to promote specific training based on local needs with the participation of producers. It also establishes an assessment and registration system that is ongoing, public and accessible on available technical services, promotes a specialized service market for the sector, with preferential treatment for producers located in marginalized rural areas, and provides non-formal education services for integral rural development.

Based on the assessments made by the OECD recently, it has become clear that **the outreach system has been diluted into the integrated approach**. No impact has been achieved on the development of human capital in rural areas or on a production level. In fact, there have been producers voicing their proposals to return to the previous model,[53] as it is not favorable for agricultural outreach to remain in a marginal position, as will be illustrated later.

- **The National Institute for Capacity Development in the Rural Sector (*INCA Rural*)**

INCA Rural has set the following strategic objectives:

- To strengthen capacities for sustainable human development in rural areas, through the coordination of inter-institutional efforts and resources on federal, state and municipal levels, by encouraging broad participation from the rural society. (*SINACATRI*)

- To coordinate and operate actions for capacity development to improve competitiveness in the rural sector and environmental protection, increasing labor productivity levels, family income and links to markets, through the

[53] This proposal was expressed at the Agricultural Innovation Forum organized by *SNITT* in the city of Querétaro on September 14, 2012

implementation of sectoral strategies for organization, training and technical support. (*SAGARPA*)

As mentioned previously, in 2009 *SAGARPA* requested from the OECD an evaluation of outreach systems, based on integral training policies through professional service providers (*PSP*). The study proposes that, on a federal level, the Subsecretariat of Rural Development – through *SINACATRI* – is responsible for overseeing the organization of the service: it must supervise the coordination and liaison between institutions at all levels, establish standards, and plan and identify priorities. This is supported by the National Institute for Capacity Development in the Rural Sector (*INCA Rural*), which is responsible for designing and coordinating training, non-formal education, assessment, accreditation and certification of professional services to support public programs at all levels. There are other institutions implementing training and outreach programs at different levels such as Trust Funds for Rural Development (*FIRA*), *Financiera Rural*, *Fundar*, etc., as well as federal, state and local governments. An important conclusion is that, although it was considered that the old system, operated as a directorate of the Secretariat of Agriculture and Water Resources (*SARH*), was ineffective, the perception is that **this new system is an inadequate replacement, and is not capable of fulfilling the general objectives of *SAGARPA***.

The current technical support system implemented through support programs is highly fragmented and is based on individual projects. Like most of the demand for these services, it is provided through *SAGARPA* support programs, and there is a dispersion of efforts and resources on smaller projects and a lack of integration from the perspective of territorial development and productivity targets. This dispersion is due not only to the individual approach focused on the *PSP*, but is also due to the multiplicity of objectives associated with the integral approach introduced around ten years ago.

In response, "in 2012 there was a new National Skills, Technological Innovation and Rural Outreach Development System that highlighted technological innovation, incorporated the new institutional setup and sought links between research-outreach and innovation. The system integrated the National Commission for Capacity Development, Outreach, Technological Innovation and Technology Transfer created on April 11, 2011, with the participation of the three subsecretariats (Agriculture, Rural Development and Agribusiness): the General Department of Livestock, the National Commission of Aquaculture and Fishing (*CONAPESCA*), and the National Service of Agro Alimentary Health, Safety and Quality (*SENASICA*). The National Institute for Capacity Development in the Rural Sector (*INCA Rural*) was appointed Executive Secretariat of

the National Commission and the executing responsibility was assigned to the National Rural Training and Technical Assistance Service (*SENACATRI*)".[54]

The National Commission seeks to accomplish three objectives:

- To link the operation of the capacity-building components and rural outreach to the innovation component.
- To systematically articulate programs to support investments of rural producers in the capacity development, technological innovation and rural outreach program.
- To integrate the capacity development, technological innovation and rural outreach system, for it to allow the promotion of generating territorial and product system projects articulated to national and state bodies responsible for driving rural development, such as state Secretariats in the industry, national, state and district councils for rural sustainable development, and state and national product system committees.

The new Skills, Technological Innovation and Rural Outreach Development Program aims to "promote capacity-building for producers, their organizations, rural families, and other groups that perform duties in the agriculture, aquaculture and fishery sectors. This would be achieved through a National Skills and Outreach Development System to provide access to the knowledge, information and use of modern technologies, their interaction with partners in research, education, agribusiness and the market, and developing their own skills and technical, organizational and management practice".[55]

There are no items to assess whether or not this organizational innovation will be effective, but what can be mentioned is its timing, as there has just been a change of government that will surely review this issue and make further proposals.

Innovation Management Agencies

In 2008, at the Technology Services Management Unit, through the Research Center for Sociology, Economics and Technology in World Agriculture and Agro-industry (*CIESTAAM*), the Autonomous University of Chapingo launched various research-related activities. These include the establishment of 29 Innovation Management Agencies in

[54] Deschamps, L. Mexican Innovation System of Food and Agriculture, Inter-American Institute for Cooperation on Agriculture, work document, Mexico, 2012
[55] *SAGARPA*. Capacity-building and rural outreach http:www.sagarpa.gob.mx/desarrollorural

the states of Chiapas, Chihuahua, Jalisco, Mexico State, Michoacán, Nayarit, Querétaro, Tabasco, Tlaxcala, Yucatán, Sinaloa, Campeche and in Mexico City.

An **Innovation Management Agency** is a group of professionals (preferably between three and seven members) with moral and additional job skills that allow them to design, operate and evaluate the impacts of intervention strategies aimed at managing innovation in food chains, with a focus on local networks.

- *Non-governmental organizations (NGOs)*

There are several NGOs in Mexico that are involved in outreach, producer organization and dissemination of technology. The sizes, sources of support and ideological orientation of these NGOs are diverse. For example, there is the Mexican Foundation for Rural Development, linked to important businessmen and funded by corporations and capitalists, mainly Mexicans. This foundation supports production projects, alongside its task of basic education outreach programs.

In organic farming, there is also recognition that its main support has come from international foundations and organizations, among which are the following: German charities Bread for the World (*Brot für die Welt*) and *Misereor*; Japan's MOA Foundation; The Inter-American Foundation, The MacArthur Foundation, The Rockefeller Foundation and The Rodin Foundation of the United States; and the Inter-American Development Bank (IDB) and the North American Fund for Environmental Cooperation (NAFEC). Another part of the support has come from Mexican non-governmental organizations such as Go Mexico – Service for Peace and Justice (*Fundación Vamos México*, *Servicio de Paz y Justicia A.C.*), San Francisco de Asís Agroecology Center (*Centro de Agroecología San Francisco de Asís*) and the Tuxtlas Community Development Group (*Grupo de Desarrollo Comunitario de los Tuxtlas*), among others.[56]

- *International or regional organizations*

The involvement of these organizations in the agriculture and food industry has a long history in Mexico and refers to the financing of infrastructure, political guidance, support for specific projects and, recently, the formation of collaborative networks. Among the major organizations are the World Bank, the Inter-American Development Bank, the Food and Agriculture Organization of the United Nations (FAO) and the Inter-American Institute for Cooperation on Agriculture (IICA).

- *Public higher education and research system*

[56] Laura Gómez Tovar & Manuel Ángel Gómez Cruz, Organic Agriculture in Mexico: an example of incorporation and resistance to globalization, CIESTAAM, Autonomous University of Chapingo, 2006

In Mexico there are many human resources training programs for agriculture and food innovation-related issues. There are 37 institutions offering degrees in agronomy and phytotechnics, more than 500 food engineering programs, 28 in veterinary medicine and zootechnics and 29 in aquaculture.[57]

However, only few institutions have established research programs. These include the Autonomous University of Chapingo, Antonio Narro Agrarian Autonomous University (*UAAAN*), the National Autonomous University of Mexico (*UNAM*), the Autonomous Metropolitan University (*UAM*) and the National Polytechnic Institute (*IPN*). Several state universities have research programs in specific areas such as the Autonomous University of Chihuahua in meat science and the Autonomous University of Baja California in marine biology and aquaculture, to name a few. Despite these examples, it should be mentioned that most of the universities and technology institutes are strictly teaching-oriented, with little research activity.

- *Private higher education and research system*

There are few private institutions with connections to food and agriculture issues. These include the Monterrey Institute of Technology and Higher Education (*ITESM*), with agronomy studies and food and biotechnology research centers. The *Iberoamericana* and *La Salle* Universities and the Western Institute of Technology and Higher Education (*ITESO*) have food and nutrition research.

- *Technical education system*

The General Directorate of Agricultural Technological Education at the Secretariat of Public Education manages 290 agricultural and forestry high school centers. Their mission is to train technicians and professionals in the agricultural and forestry sector to be capable of improving the quality of food production, both in extractive or primary activities (such as transformation or secondary activities), and promoting and encouraging technological research. These centers also offer training services for farmers, technical assistance for the production sector and technology.

Training and technical assistance are also offered at the Rural Development Education Brigades (*BEDR*) and at the Training Unit for Rural Development (*UNCADER*) as exclusive functions.

Meanwhile, the General Directorate of Marine Science and Technology of the *SEP* manages 15 technical courses related to fisheries and aquaculture that are taught in 31 locations in the different marine regions of Mexico.

[57] www.emagister.com.mx, consulted on October 15, 2012

- *Certifying agents*

There are 16 organic products certifiers, 13 of which are foreign. Moreover, within the framework of the Mexico Supreme Quality program, there are nine certifying organizations for plant products, four for livestock and two for aquaculture products.

The Pollution Risk Reduction Systems at the National Service of Agro Alimentary Health, Safety and Quality (*SENASICA*) are the measures and procedures established by *SAGARPA* in the Mexican Official Standards and other applicable legal rulings to ensure that, during the primary production process, plants are given optimal health conditions by reducing physical, chemical and microbiological pollution through the application of Good Agricultural Practices via the Federal Plant Health Law (*LFSV*). Businesses and producers involved in the primary production of agricultural products in the production, harvesting and/or packing stages that comply with the provisions in the established measures and procedures will receive the certificate of implementation of Pollution Risk Reduction Systems from *SENASICA*.

- *Technology-based companies*

In Mexico there is a business incubator program within the SME Fund (*Fondo PYME*) that is coordinated by the Secretariat of Economy, with over 550 incubators across the country today. Only 17% of those incubators are for high-tech companies. There are currently no specialized incubators in agribusinesses, although there are conditions to incubate companies involved in biotechnology, and food and agriculture products and processes.

- *Specialized journalism*

In Mexico there are various mediums, primarily the print media, engaged in agriculture and food issues. Virtually all chambers and producer associations have specialized magazines that reach producers and companies. Support and Services for Agricultural Trading (*ASERCA*) manages a monthly magazine, *Claridades Agropecuarias*, with broad coverage, and there are several private specialized media in the sector. Cultural radio and television cover scientific, technological and economic developments that are relevant to the sector. Online information has become a very economical medium, although a drawback is that its coverage is still limited in rural areas.

- *Producers*

A typology of producers has already been presented in Concept 1. Commercial farmers have access to innovations, mainly through the purchase of equipment, genetic

material and expert advice. They have relationships with research institutes that are mainly supported by the recruitment of technical services.

Subsistence producers, meanwhile, have little access to innovations and are dependent on government programs. This segment holds what is known as an informal innovation system based on the free exchange of varieties and traditional knowledge.

Government agencies

Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*SAGARPA*)

SAGARPA is a main player in *SNIAs* in Mexico, since it passes policies and manages public resources for research, technology transfer and outreach. According to the 2010 *SAGARPA* program structure, the budget program called National Agricultural Research System sets aside resources for three political tools that are linked to the main participants of the institution for innovation in the sector:

- Sector Research Fund for Agriculture, Livestock, Aquaculture, Agrobiotechnology and Plant Genetic Resources (*SAGARPA-CONACYT* Sector Fund).
- National Research and Technology Transfer for Rural Sustainable Development (*SNITT*).
- Scientific collaboration agreements.

Sector funds are trusts that the departments and agencies of the Federal Government, together with *CONACYT*, can build to allocate resources to scientific research and technological development in the relevant sector. Its objectives are as follows:

• *To promote the development and establishment of scientific and technological skills for the benefit of the sectors.*
• *To channel resources to contribute to the comprehensive development of sectors through scientific and technological activity.*

The *SAGARPA-CONACYT* Sector Fund in particular aims to finance spending and investment for scientific or technological projects in knowledge areas required by the agricultural and fishing sectors.

For its part, ***SNITT*** is an advisory body of the Inter-Secretarial Commission for Sustainable Rural Development (*CIDRS*) that, according to the mandate stated by the Rural Sustainable Development Law,[58] aims to coordinate and schedule the actions of

[58] Since 2001, agricultural policy and its implementation have been based on the Rural Sustainable Development Law, which supports the creation and diversification of jobs, guarantees the

public institutions as well as private and social organizations that promote and conduct scientific research, technology development, validation and knowledge transfer in agriculture, in order to identify and address national problems on these issues, such as the immediate needs of farmers and other members of the rural society and their agricultural activities.

As a coordinating body, *SNITT* is primarily responsible for:

1) Identifying the demands of the food and fisheries industry and linking them to scientific and technological services of public institutions and private and social agencies.
2) Operating the Knowledge Management System, through which it systematizes and discloses the results of scientific and technological research.
3) Promoting a culture of innovation and technological development in the agricultural and fishing sectors.

SNITT's mission is "to propose policy guidelines that allow a permanent strategy for the generation of research, technology transfer and innovation to achieve and maintain the competitiveness of the rural sector, and to join public and private projects, programs and resources for research, technology transfer and innovation in production chains of sub-sectors. The objective of this is to ensure the participation and contribution of research and higher education institutes, service providers, social and private organizations, producer associations and state and local governments, in order to achieve competitiveness of the agriculture and food, aquaculture and fishery industries".

The *SNITT* Executive Secretariat, responsible for the operation of the National System, promotes research and technological development in accordance with the model shown in Figure 2. The logic of the model is suitable, but it is very difficult to be carried out, as *SNITT* does not have an Executive Secretariat with the resources and organizational structure needed to drive all actions considered.

We should not lose sight of the fact that *SNITT* is a system, a mechanism for coordinating the activities of other parties in the institutional arrangement of the *SNIA*. To fully achieve the required level of coordination, an Executive Secretariat would be needed to provide incentives and that has only been partially achieved when assuming the administrative secretariat of the *SAGARPA-CONACYT* Sector Fund. This allows it to lead research programs, but not necessarily to act on the weakest link that is technology transfer.

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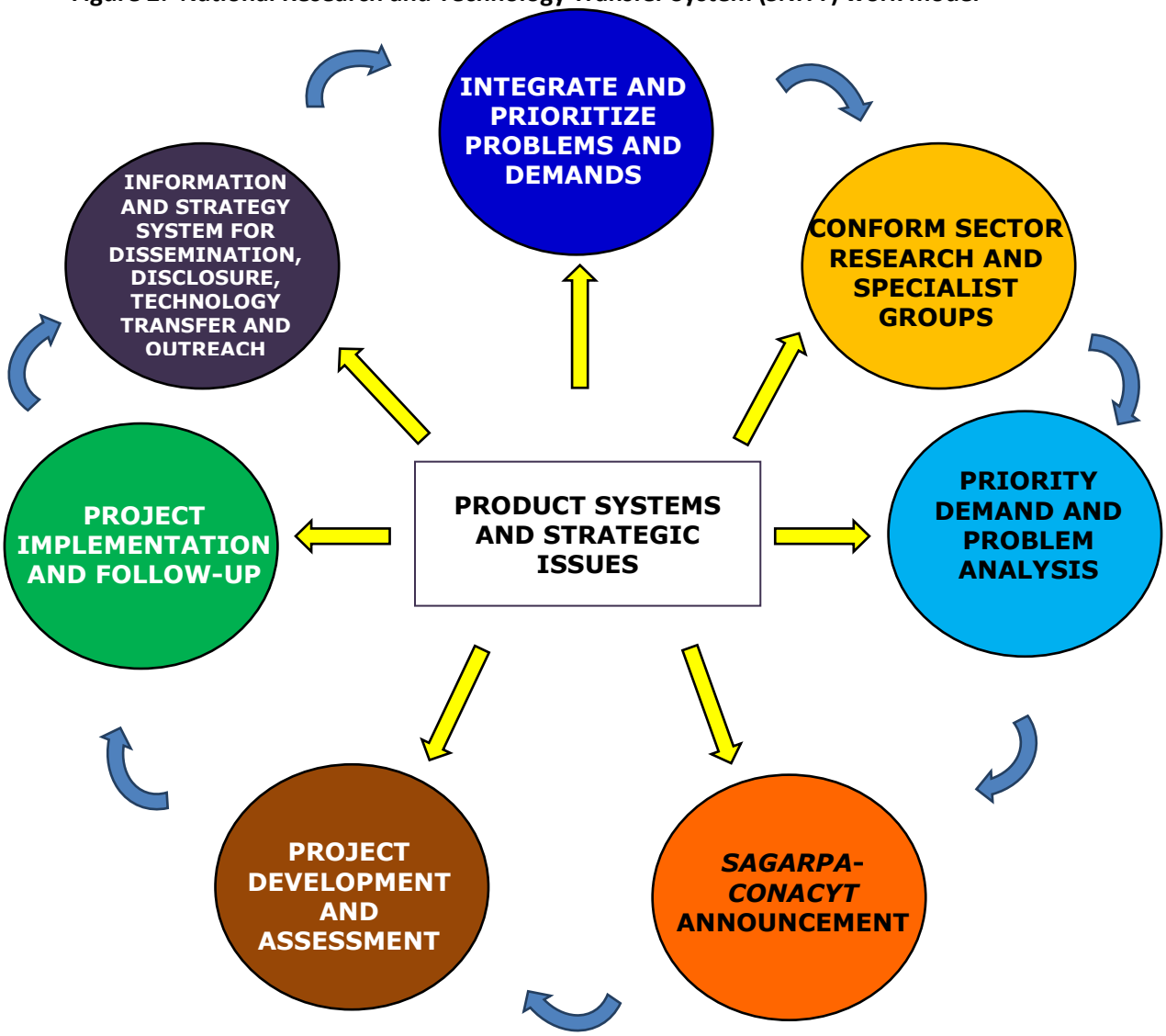
incorporation and participation of the small-scale agriculture sector into national development, and prioritizes marginalized areas and the economically-weak rural sectors.

The system for dissemination, disclosure, technology transfer and outreach information and strategy, referred to in a single package, depends on the proper functioning of other organizations; the *SNITT* Executive Secretariat has made exceptional efforts to disseminate specific technologies among specific groups of producers, such as sugarcane workers, and outreach activities in support of agricultural biotechnology and *MasAgro* activities. However, the scope remains very limited in full accordance with the level of resources allocated to the Executive Secretariat. Therefore, **this mechanism needs to be reviewed to significantly strengthen the technology transfer component**, as that is the link where the ideal model proposed by *SAGARPA* breaks.

Figure 2: National Research and Technology Transfer System (*SNITT*) work model



Source: *SNITT* (2012), Institutional presentation by Jaime Paz during the interview conducted for this project.

In relation to scientific collaboration agreements, *SAGARPA* and the International Maize and Wheat Improvement Center (*CIMMYT*) signed the *SAGARPA-CIMMYT* Scientific Collaboration Agreement 2009-2012 in order to combine actions and resources to implement practical projects, to lead technological innovation through the development, adjustment and exchange of technologies and participatory and sustainable methodologies that contribute to improving the quality of life of the Mexican food and agriculture industry, as well as increasing maize and wheat yields.

The **General Directorate of Productivity and Technology Development** at *SAGARPA* proposes a participatory model of innovation management based on a network of members illustrated in Figure 3, with the message that innovation management is everyone's job. This directorate has, among others, the following key functions within the *SNIA*:

- To propose policies, strategies and programs to promote investment and capitalization of agricultural production units.
- To promote strategies to encourage investment in agricultural production assets, to be able to streamline primary production and controlled environment processes, and the harvest of agricultural goods.
- To propose policies, strategies and programs that will create conditions to stimulate productivity and sustainability of agricultural production units, through the modernization of agricultural machinery and the use of biotechnology.
- To participate, alongside the relevant institutions, in the formulation and implementation of programs and projects to promote the modernization and automation of irrigation in production units.
- To implement programs and strategies for access to, and conservation and sustainable use of genetic resources for food and agriculture, including those allocated to the production of bioenergy.
- **To propose strategic research lines in agriculture and livestock**, so that, through *SNITT*, there is coordination in the actions of public and private institutions, and private and social agencies that will carry out scientific research, technology development and knowledge transfer in the agriculture and livestock sectors.
- **To disseminate the progress of scientific and technological research** in the field of agriculture, as well as support programs and projects for agricultural research offered by individuals, agencies and institutions, both nationally and internationally, for producers, professionals and institutions linked to social and private sectors.
- To propose policies, programs and actions for the standardization, testing and regulation of plant nutrition goods, through the verdict on its biological effectiveness.

- To propose policies and strategies to stimulate research, quality production, registration, certification and trade of seeds and other plant production material, in coordination with the National Seed Inspection and Certification Service.
- To design, coordinate and oversee the strategy for the management and consistency of Secretariat programs related to promoting agricultural productivity and technological development.
- To promote support schemes for the supply and use of goods, aimed at increasing the productivity and competitiveness of the agricultural sector.
- To participate in the development of proposals for the design and operation of information systems to support agricultural development.

As can be seen, *SAGARPA*, through the General Directorate of Productivity and Technology Development (*DGPDT*), must undertake the task of giving direction to and assuming the role of coordinating the institutional arrangement of the *SNIA*.

Figure 3: Innovation system agents, in accordance with *SAGARPA*.

Source: *SAGARPA* (2012), Presentation by Dr. Arnulfo del Toro during the work session on *Red Innovagro*.

SENASICA

The National Service of Agro Alimentary Health, Safety and Quality (*SENASICA*) is a decentralized body of the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*SAGARPA*), and is aimed at healthcare actions to protect agricultural, aquacultural, and livestock resources for pests and diseases of quarantine and economic importance. It also regulates and promotes the implementation and certification of systems to reduce risks of food contamination and food quality, to facilitate domestic and international trade of goods of plant and animal origin.

National Seed Inspection and Certification Service (*SNICS*)

SNICS is a decentralized body of *SAGARPA*, responsible for regulating and monitoring the implementation of laws on seeds and plant varieties.

It has three main activities:

- Verifies and certifies the origin and quality of the seeds.
- Legally protects the rights of those who obtain new plant varieties through plant breeders' rights.
- Coordinates activities for plant genetic resources for food and agriculture.

Produce Foundations

One of the main institutional innovations made in recent years is the creation of the *Produce* Foundations in 1996. Its purpose is to fund research, validation and technology transfer. These foundations were established statewide and have a federal coordinating body, the Coordinator of *Produce* Foundations (*COFUPRO*).[59] The foundations are

[59] According to Ekboir et al., "the existence of 32 foundations had contradictory consequences. To start with, the system became very fragmented with small organizations, increasing the operational costs and

funded equally, federally and by the states, and receive resources from the Support Program. When the *Produce* Foundations were created in 1996, they had a budget of US$11 million. This increased to US$31 million in 2005, and in 2009 reached US$46 million, which accounts for the increase in their ability to influence the research system. Moreover, the Foundations' presence in states around Mexico has contributed to a better identification of local demand and allows producers to have more influence on the technology program.

Demand is identified by using an established methodology for defining **innovation agendas**, with a strong focus on supply chains. According to the agendas, the *Produce* Foundations make announcements statewide and fund projects for the states. In an innovation agenda the following points are identified and prioritized:

- Strategic system products, considering their current situation and where they want to go in terms of competitiveness.
- The critical elements or innovation demands of each system product and/or strategic issue in the state.
- Annual goals and management and impact indicators to measure development.
- Synergies or complementarity of actions or supports for other support program components or other *SAGARPA* programs, such as technical support or production assets needed to strengthen and ensure the transfer and adoption of innovations.

An innovation agenda is therefore the document in which the actions are prioritized in order to address the problems and needs of research and technology transfer of system products and strategic issues for the rural sector.

According to Ekboir et al.[60], the current decentralized structure of the Foundations has two important advantages: (a) the foundations have significant local presence, allowing them to be a good channel of communication with the producers and the states, and (b) they are a decentralized exploration structure. However, this decentralization has also caused problems: (i) the strong mismanagement of the state governor;[61] (ii) there are

limiting the actions of individual foundations. Some foundations recognized this problem and created a coordination (*COFUPRO*) for better negotiation with the federal government and for a better economy. The variety of foundations also allowed the emergence of a group of innovative individuals that drove the foundations to a functional separation of the governments and imparted a joint innovative dynamic", 2006.

[60] Javier M. Ekboir, Gabriela Dutrénit, Griselda Martínez V., Arturo Torres Vargas & Alexandre Vera-Cruz, *Produce* Foundations ten years on from their creation: looking to the future, ISNAR Division Discussion Paper 10, Washington, D.C., 2006

[61] It often happens that this intervention causes changes of priority and agendas are modified because of local interests that differ from those of farmers.

no efficient mechanisms to systematize and learn from the experiences of the foundations, which reduces the value of the exploration; (iii) in many of its actions, the system is too fragmented and subject to institutional constraints, making it inefficient, and (iv) operating and transaction costs are high. Furthermore, because the demand mainly comes from farmers, projects almost always focus on primary production.[62] The administrative structure forces the agendas and projects to have an annual horizon, which leads to a **very short-term view that sacrifices strategic research**.

The Foundations have become one of the main sources of financing for the sector, which makes them the **most influential institutions for establishing priorities in the research system**. Consequently, the *Produce* Foundations define much of the *INIFAP* program and other executive bodies in the system, and they also influence the allocation of *SAGARPA-CONACYT* Sector Fund resources.[63] Attention to the needs expressed by the farmers is undoubtedly an advantage, but this can also prove negative because of the vision reportedly being focused on short-term issues and not on long-term scientific and technological challenges that will be critical to competitiveness of the sector.

Its effectiveness in identifying demand and in processing applicable announcements is critical to the general efficiency of the publicly-funded innovation system.[64] It has therefore been suggested that the *Produce* Foundations are the most important mechanisms to address the immediate innovation needs of agricultural, aquacultural and fishery chains, particularly through validation and technology transfer. However, there is a perception that technology transfer is being neglected and there is no link between transfer and outreach to ensure wide disclosure.

COFUPRO

Established 15 years ago, the mission of the Coordinator of the *Produce* Foundations is to help strengthen the *Produce* Foundations for the fulfillment of its mission.

[62] During the interviews arose the idea that, although it is good to listen to the farmer, it should not be the only defining factor of the agenda because this overlooks the long term, and only simple solutions are created.
[63] For example, in Guanajuato resources were promoted with the joining of *CONACYT* funds for networks and resources were brought in by the local *Produce* Foundation.
[64] OECD, Agricultural outreach analysis in Mexico, Organisation for Economic Co-Operation and Development, Paris, 2011

Based on its values and in order to meet its objectives, *COFUPRO* applies the following strategies:

- Establish a mission, vision and shared culture to reassess the role of the Mexican countryside for its economic development.
- Increase the competitiveness and sustainability of agro-food and agro-industry chains through technological innovation.
- Contribute to society in general, and recognize the importance of technology generation and transfer in regional and national development.
- Participate in the research agenda of institutions to respond to the demands and needs of those involved in and agro-food and agro-industry chains.
- Gain the confidence and credibility of producers and other participants in the supply chain.
- Perfect mechanisms to capture and prioritize demand for each system-product innovations and for each agro-ecological region.
- Promote partnerships to optimize the use of resources in the generation and adoption of technological innovations.
- Diversify sources of funding, with emphasis on the financial support of the users.
- Liaise and build on the experiences of other countries' sectoral organizations with a similar mission to the Foundations.
- Strengthen the responsiveness of research institutes and technology transfer in Mexico.
- Establish an incentive system for productivity of researchers and change agents.
- Have, in the short term, an efficient information system, to detect and use technological advances both at home and abroad.
- Encourage the development of effective research and technology transfer models, reducing the time of generation and adoption of technological innovations.
- Create awareness among officials, researchers, academics and users about caring for the continuity between generation, validation and technology transfer.
- Focus funding on priority, inter-institutional and regional research, validation and technology transfer projects required by the sector.
- Document, promote and apply successful lessons of models and strategies for technology transfer.
- Enhance monitoring and assessment of generation and transfer projects by external auditors.

- Promote a National Agricultural and Forestry Research System, with the participation and leadership of society, giving a right direction to the system.

Alongside the *Produce* Foundations, *COFUPRO* has been able to establish a national network for technological innovation, with the continued involvement of users in defining the research and technology transfer agenda nationwide. There are currently 3,500 participating producers in the 32 states, with involvement in advisory and management boards nationwide.[65] Additionally, the following accomplishments of *COFUPRO* are noteworthy:

- Establishment of a national network for technological innovation.
- Average annual funding of 1,100 research and technology transfer projects.
- Permanent adoption of competitive technologies.
- A comprehensive *Produce* Foundations system to enable the systematization of information on implemented projects and their results, avoiding duplications that appeared in the past.
- Linking of federal, state and producer resources for annual average amounts of $650 million Mexican pesos (*MN*), to fund research and technology transfer.
- Development of a network of automated weather stations that provide real-time information to aid decision-making for farmers.
- Strategic alliances with international organizations, which have allowed to be more professional and to have institutional development, in the development of our science and technology agenda in the countryside.
- Strengthening of the national research system, and being the only sector in Mexico that is organized and involved in defining the national agenda of research and technology transfer.

According to Ekboir et al. (2006),[66] *COFUPRO* is an organization focused on facilitating learning about foundations, supporting *SAGARPA* and state governments with original information and promoting interactions between different members of the agricultural sector, in order to strengthen its capacity for innovation. The scope of *COFUPRO* is the science and technology policy and the links between research organizations and producers. Given this profile, there are four main learning objectives:

- The collection of producers' information needs.

[65] Deschamps, L. & Escamilla, G., Towards consolidating the Mexican Innovation System, Inter-American Institute for Cooperation on Agriculture, Mexico City, 2010

[66] Javier M. Ekboir, Gabriela Dutrénit, Griselda Martínez V. Arturo Torres Vargas & Alexandre Vera-Cruz, *Produce* Foundations ten years on from their creation: looking to the future, ISNAR Division Discussion Paper 10, Washington, D.C., 2006

- Identification of existing research capabilities and performances of researchers.
- Identification of how relationships between industry members (academia: institutions, researchers and research groups; producers, government) influence the learning ability of the members.
- The improvement and standardization of organizational aspects of several foundations: operational, internal relations between *COFUPRO* and the *Produce* Foundations, decision-making, etc.

The National Council for Science and Technology (*CONACYT*)

CONACYT is the highest government organization involved in science, technology and innovation. Its mission is to "promote and strengthen scientific and technological research, and quality innovation, and to provide advice to the Federal Executive on these matters. To articulate the National Science and Technology System to help the Mexican society carefully face its main challenges and raise its quality of life".

During the Felipe Calderón administration (2006-2012), the strategic areas for the solution to Mexico's most urgent problems were:

- Information and communication technology
- Biotechnology
- Advanced materials
- Design and manufacturing processes
- Urban and rural infrastructure and development, including social and economic aspects.

According to *CONACYT*, innovation in these areas will be aimed at serving disadvantaged populations. Actions for attention to women, people with disabilities, and indigenous and migrant groups will also receive special attention.

The main instrument of structural change in resource-management for science, technology and innovation is in the constitution of *CONACYT* Funds. The establishment of such funds allows the Board to interact both with the state departments, state governments and federal agencies; and with academic and scientific institutions and private companies that are a part of the science and technology system in Mexico.

Through sectoral, mixed, international cooperation and institutional funds, efforts are coordinated with a multiplier effect on the generation of knowledge, innovation, technology development and human resources training, as well as in strengthening the scientific and technology skills required in this country. The concurrent contributions of sectoral agencies, state governments and some local governments have caused the

availability of resources for projects to increase significantly, as well as the administrative complexity.

There is no doubt about the **leading role of *CONACYT***, because of its role as funds administrator, as well as having the mission to develop policy proposals in this area.

Secretariat of Economy

This secretariat is the highest body of government and its mission is to support business growth, job creation and trade regulation. It is responsible for defining industrial and sectoral policies and managing funds for business development, particularly for SMEs.

In terms of innovation, the Secretariat of Economy has the following powers:

Managing the Intersectoral Innovation Committee (*CII*) is a body authorized by the Science and Technology Law to design and operate innovation policy. Three sectors should liaise and collaborate very closely: government, academia and industry. The Committee was established by the reform of June 12, 2009 on the Science and Technology Law. It is led by the Secretariat of Economy, the National Council for Science and Technology (*CONACYT*) and the Secretariat of Public Education (*SEP*).

As part of the Committee's work, in 2011 the Secretariat of Economy launched the National Innovation Program, the purpose being to establish public policies that promote and strengthen innovation in production processes and services, to increase the competitiveness of the national economy in the short, medium and long term. In order to do this, it seeks to promote and strengthen innovation in production processes and services to increase the productivity and competitiveness of national production.

The Secretariat of Economy is responsible for the management of the following funds:

- **Technological Innovation Fund (*FIT*).** Public trust of the Secretariat of Economy, the Subsecretariat for Small and Medium Enterprises (*SYPME*) and *CONACYT*, in order to support micro, small and medium enterprises, as well as individuals with business activity who develop or adopt innovation and Technology development activities.
- **Sectoral Innovation Fund (*FINNOVA*).** Fund created in 2010 in conjunction with *CONACYT* in order to boost innovation particularly in biotechnology, clean technology and knowledge transfer office management.
- **Venture Capital Fund.** The first Business Venture Capital Fund, created jointly by the Secretariat of Economy and *Nacional Financiera* in 2010, with the objective

of increasing the availability of private capital for early-stage innovation projects with high potential for success.

Other relevant government agencies

- As a decentralized administrative body of *SAGARPA*, Support and Services for Agricultural Trading **(*ASERCA*)** has to design, implement, monitor and assess public policies that, in support of rural issues, are listed in the National Development Plan. They are also listed in the medium-term sectoral plan, to strengthen development in the sector, agricultural profitability and the income of farmers in Mexico, through the direct implementation of support programs for producers and for the promotion for funding and organizational mechanisms for food and agriculture chains to join national and international markets with competitive and profitable conditions.

- Trust Funds for Rural Development, ***FIRA***, are four public trusts that have been set up by the Federal Government in the Bank of Mexico since 1954. The aim of *FIRA* is to issue credit, guarantees, training, technical support and technology transfer to the country's agricultural, rural and fishing sectors. It operates as a second-tier bank, with its own assets, and places its resources through **banks** and other financial intermediaries.

- ***Financiera Rural***, whose mission is to assist the State's priority activity of promoting the development of farming, forestry, fishing and all other economic activities linked to rural areas, in order to raise productivity and improve the standard of living of its people, through giving credits and managing its resources wisely, efficiently and transparently.

- The Shared Risk Trust ***FIRCO***, is a public agency established by Presidential Decree and zoned at the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*SAGARPA*), to promote agribusiness, rural development in microbasins and perform technical duties in agriculture and fishery programs. The support of the programs operated by *FIRCO* have been based on the concept of risk-sharing, a government policy instrument, which contributes to comprehensive development in the rural sector through the channeling of additional financial resources, to minimize the risk involved in investing in strengthening and diversifying production chains. These resources will be recoverable at no financial cost or profit sharing, to facilitate their

recovery investment attached to its success. For resources classified as subsidies, their recovery will benefit the producers themselves.[67]

Features of an innovation management model in the agribusiness and agroindustrial sectors driven by *SAGARPA*

Figure 4 illustrates the inclusive vision of *SAGARPA* to achieve an effective innovation process, with research, technology transfer and disclosure activities, based on a knowledge network that is catalyzed by various funds managed by *CONACYT* and other national and international organizations.

The logic is represented along the transversal axis and is based on a **linear model of innovation** that is difficult to reproduce. The problem starts with the complexity of the institutional arrangement, which leads to the path of very ambitious targets for different elements of the system, without attaching sufficient resourcing.

Researchers have little impact on the generation of new knowledge, partly due to financial management problems with annual cycles that create short-term pressure, which leads to the sacrifice of strategic research.

Produce Foundations have taken a very important role as they have the resources to finance projects that meet farmers' innovation requirements. However, under those demands made by the farmers, they have induced a productivist vision that disregards the definition of a research agenda with long-term impacts.

Another significant obstacle, as confirmed in our analysis of interactions, is the lack of coordination; it has failed to make research centers, goods suppliers and advisors jointly participate in large-scale projects that generate sensitive impacts on the *SNIA* and, of course, in improving the competitiveness of Mexican agriculture.

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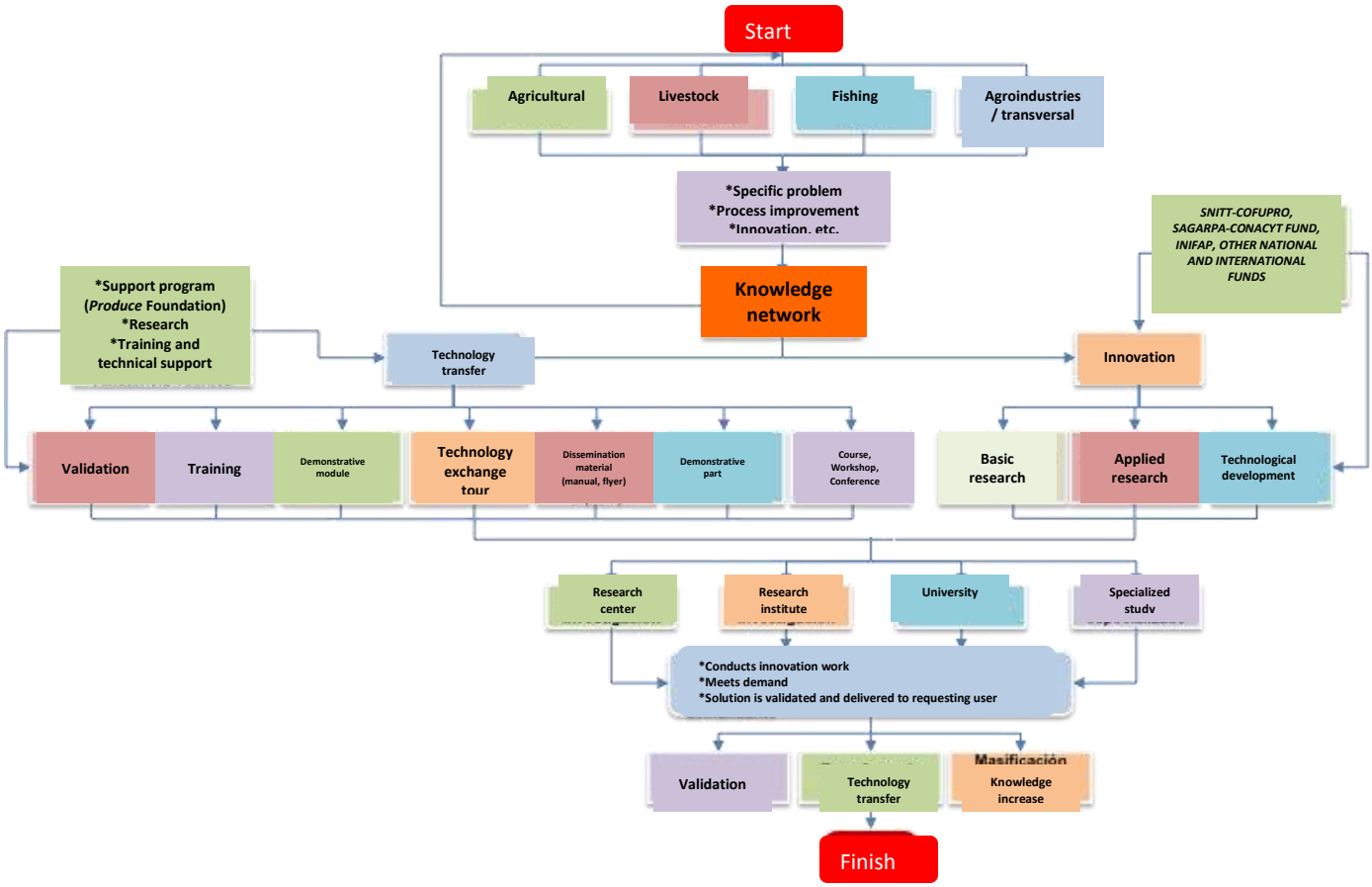
[67] *FIRCO* manages the following programs: Protected Agriculture program, Bioeconomics program, Bioenergy and alternative sources program, Livestock Conditioning Center program, Diversification of Sustainable Production program, *FIMAGO* program (capitalization of grain and oilseed production organizations), *PROMAF* program (technical support, training and technological innovation for maize and leguminous product farmers), *Provar* program (improvement in post-production processes), Genetic Resources in the Aquatic Subsystem program, *TIF* program, Irrigation technification program, Humid Tropics program.

It is also noticeable that the model does not include the participation of companies and other members of the private sector. Thus, it ignores the importance of goods and machinery manufacturers and various NGOs in the formation of knowledge networks and, of course, in the validation and technology transfer, as well as its use by farmers.

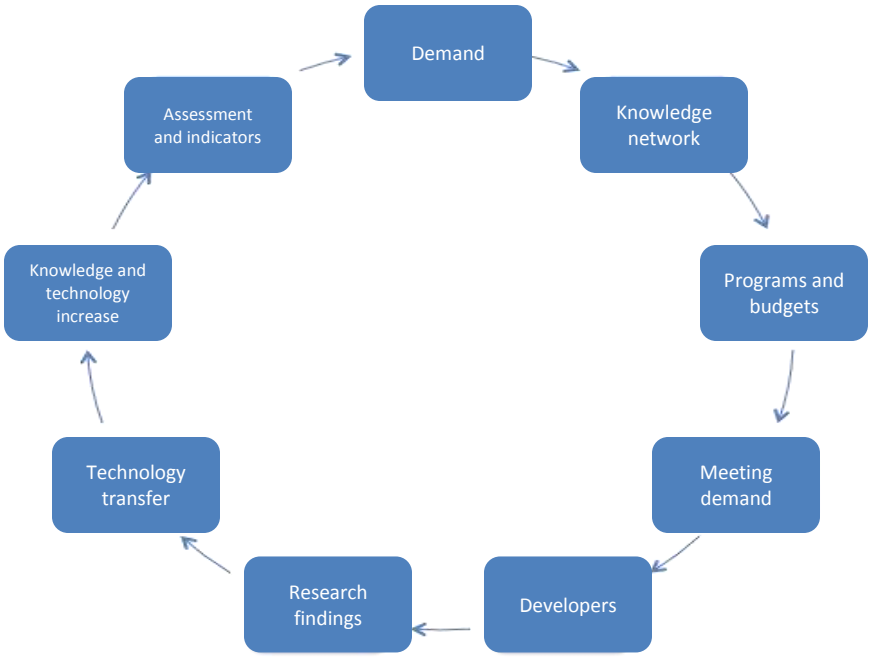
Figure 4. Innovation management model by *SAGARPA*



Source: *SAGARPA* (2012), Presentation by Dr. Arnulfo del Toro during the work session on *Red Innovagro*, September 17, 2012

Figure 5 also makes clear that the dominant conception at *SAGARPA* is an ideal model based on meeting the demands through technology development that points more to the notion of a research system than an innovation system. Much of the technology that has an impact on farmers is bought already built into machinery or by purchasing of specialized goods. Agribusiness firms also acquire licenses on proven technologies elsewhere. This is a reality that must be accepted by designing a model of innovation: **critical knowledge sources are numerous and go beyond research**.

Figure 5. Innovation generation model proposed by *SAGARPA*.



Source: *SAGARPA* (2012), Presentation by Dr. Arnulfo del Toro during the work session on *Red Innovagro*, September 17, 2012

Summary of the presence of *SNIA* participants

Practically all of the typology of the relevant members of the *SNIA* is available.

For *SAGARPA* coordinators the concept of the *SNIA* adheres to a linear approach to innovation. This fact means that there is excessive reliance on the first link and technology transfer takes second place. *SNITT*, the instrument designed to influence this link, has an Executive Secretariat that does not have an organic structure or resources, because it was thought that it could achieve its objectives only by coordinating with other members of the system. This has not worked well.

The action of the *Produce* Foundations has been very important in promoting research that responds to the demands of producers. However, this has led to a very short-term view that involves "productivist" research that neglects strategic elements.

A Mexican *SNIA* can therefore be described as a research system with few innovative components.

The knowledge-generating bodies (research centers and universities) do not have effective tools to transfer their results to companies or producers.

The idea of *SNIA* focuses excessively on public sector institutions, neglecting the contributions of individuals from private institutions, who play an important role as disseminators of innovation. However, most companies do not conduct local R&D activities, instead promoting technology developed in other countries.

The relationship between knowledge-generators and companies is budding. This prevents making connections with disseminators.

Financial organizations have various support schemes for farmers and companies, but they do not have effective instruments to finance technology development projects, create new businesses or adopt technology. Their requirements often exclude a wide range of producers, which can widen performance gaps.

Role of the members of the National Agricultural Innovation System (*SNIA*)

To complement the review of documents, a workshop was held on August 31, 2012, to collectively identify the role of the main members of the *SNIA*. Appendix 1 provides a list of participants in the workshop.

Appendix 3 condenses the results of the workshop organized on August 30, 2012, where the objective was to identify the main members of the *SNIA* and their roles, also evaluating their performance and interaction patterns. This analysis allows us to observe more closely the role of the main members of the system and is the basis for the table of the roles of the member groups listed in the Guide.

Additionally, as part of the interviews conducted with experts in this study (see Appendix 2), interactions were identified between members of the *SNIA* and their intensity, in order to assess the degree of integration of the system and its most influential members.

Based on this analysis, the member group description matrix proposed in the Guide is summarized in Table 1:

Table 1. Role of member groups in the *SNIA*

Member group	Brief description of current situation*:	Main role within the *SNIA*	Type and degree of relationship and interdependences with other members	Main strengths within the *SNIA*	Main weaknesses within the *SNIA*	Main trends for future role in the *SNIA*
Goods, machinery and service providers	3. They have a strong presence within the SNIA	Supply of goods and technical support to farmers through commercial channels	Strong relationship with commercial farmers and little relationship with knowledge bidders	Investment, access to advanced technology and relationships with farmers and companies	Little relationship with R&D centers	Remain as they are at present, unless there are more active policies
Agro-industrial processors	3. Presence throughout Mexico	They are the clients of primary producers and often provide consultancy	They provide technical support to farmers, and collaboration agreements with technology centers	They attract innovations from parent establishments and equipment suppliers	Big technological and economical differences between companies	Strengthening in response to market demands for safety and added value
Technology transfer agents and organizations	3. Presence throughout Mexico	They provide suppliers with training, information and consultancy	Mainly with farmers and funding organizations	They have public support and certain access channels to farmers	Topical dispersion and lack of structure	New program to arrive late, but will have a favorable impact

Research agents	**3. Presence throughout Mexico**	**Research in relevant areas, in accordance with agendas**	**They are dependent on public funds (Sectoral Fund and foundations) and have indirect relationships with farmers**	**They have human capital and infrastructure for technology development**	**Lack of effective technology transfer mechanisms**	**The Science and Technology Law can change incentive systems and bring about further liaison**
Teaching system	**3. Presence throughout Mexico**	**Training for professionals and technicians**	**Contact with local farmers and research centers**	**Facilities, information and proximity to farmers**	**Lack of capacity to develop technologies**	**Possible strengthening of links with researchers**
Commercialization and distribution agents	**3. Presence throughout Mexico**	**Direct contact with customers for product distribution**	**Relationships with farmers through intermediaries (collectors) and agro-industrial companies**	**Capacity to induce innovations in the market**	**Very little relationships with innovators**	**No changes expected**
Financing agents	**3. Presence throughout Mexico**	**They support various programs and projects**	**They determine priorities and ways to undertake projects. They have a dominant position. Strong relationship with certain farmers**	**Strong capacity to lead innovations due to their economic power**	**Bias towards interests of groups and politicians**	**Improvement from change of policies**
NGOs	**3. Presence throughout Mexico**	**Training and technical support**	**Strong relationship with groups of farmers**	**Capacity to respond and relationships with farmers**	**Lack of technical capacities to innovate**	**No changes expected**
Government	**3. Presence throughout Mexico**	**Guidelines on policies, funds management and regulation and organization of groups**	**Strong relationship with knowledge purveyors, financiers and farmers. Very little relationships**	**Financial resources and institutional mechanisms**	**Dispersion and lack of continuity. Strong influence on interest groups**	**Policy changes are expected with the new administration**

			with companies			

Source: Developed in accordance with the methodology guide, workshop and consultations with specialists

***0 – not physically present in Mexico**
1 – present but represented by third party
2 – physically present in Mexico but restricted to some regions
3 – physically present in practically all of Mexico

As can be seen, in terms of presence, all parties have relevance throughout Mexico. All the different members are present and the different functions associated with an innovation system are fulfilled. Problems arise at the level of interactions (see next section of this document) and the great heterogeneity in the flow of resources and knowledge.

The innovation system works reasonably well for commercial agriculture and for large agribusiness firms, although links with knowledge generators are rather scarce; as has been mentioned, these members are turning to other sources of technology.

However, the performances of small farmers, agribusiness SMEs and subsistence agriculture (where capabilities are minor and there are not enough resources to go to an open technology market) are poor. The system is not providing the timely solutions required in this segment.

Interactions between the members and the integration of the *SNIA*

As mentioned, in the context of the study, a specialist workshop was held on August 31, 2012 at the Autonomous University of Chapingo, to collectively discuss the following questions about *SNIA* members:

- Which public and private members participate effectively in national agrifood innovation systems (not only those involved in research, but also those who are

actually responsible for the incorporation of knowledge and ownership of the resulting value of this incorporation)?

- How do the members interact and how do they determine innovation in the *SNIA*?
- Who are the dominant members that determine the modernization movement and innovation system dynamics?
- Which members are most capable of generating and owning value in the *SNIA*?
- How could we characterize members' involvement in the systems in terms of their ability to manage the innovation process and what are the strengths and weaknesses of these members?
- What is the current pattern of interaction between the different members of the *SNIA* and how it should be?

In short, the objective was to define and assess the performance and interaction of the various members of the *SNIA*, in order to recommend policies and actions to improve performance.

INTERACTION MATRIX

With the information obtained in the workshop, we created a matrix containing the list of relevant members of the *SNIA* and their relationships (Appendix 4), taking into account the strength of their relationship. To classify information, ordinal scales were applied under the following logic:

- **Value 0, desirable but absent interaction:** When the interaction between members is not present. We should clarify that antagonistic relationships are also placed here.
- **Value 1, formal interaction:** The interaction between members is formalized by agreements, rules or laws, but is not systematically put into practice.

- **Value 2, intermediate:** The interaction between members is in development. There are already some favorable results, but no systematic relationship is recorded.
- **Value 3, strong.** There is interaction between the members, including the combination of financial and human resources, cooperation and systematic feedback.

With this information, we made a graphical analysis using the NetDraw© software package. Details are provided below, in line with each level of relationship intensity.

LEVEL 1: DESIRED OR ANTAGONISTIC RELATIONSHIPS

This level includes the members of the *SNIA* who have not shown strong and systematic relationships with the rest of the system (the relationship is antagonistic). Participants at the workshop highlighted the following cases:

i. The Secretariat of Economy does not establish positive relationships with other members of the system. Participants at the workshop said that the Secretariat focuses its resources on the business class with higher financial and commercial capacity, leaving out smaller, rural enterprises.

ii. An antagonistic relationship that was identified was the one between the Secretariat of Environment and Natural Resources (*SEMARNAT*) and *SAGARPA*, because while the former promotes an environmental agenda based conservation with no productive components, the latter promotes competitive production and the creation of agribusinesses.

LEVEL 2: FORMAL INTERACTION

Located at this level of interaction are those organizations and institutions that establish relations based on agreements, rules or laws, as part of the fulfillment of the fundamental administrative goals.

For example, in Figure 6 we can see universities linked to the rest of the system through different guidelines, councils and committees. However, the complexity of its rules, the absence of adequate incentives and a linear vision of science complicate universities' full interaction with the rest of the *SNIA*.

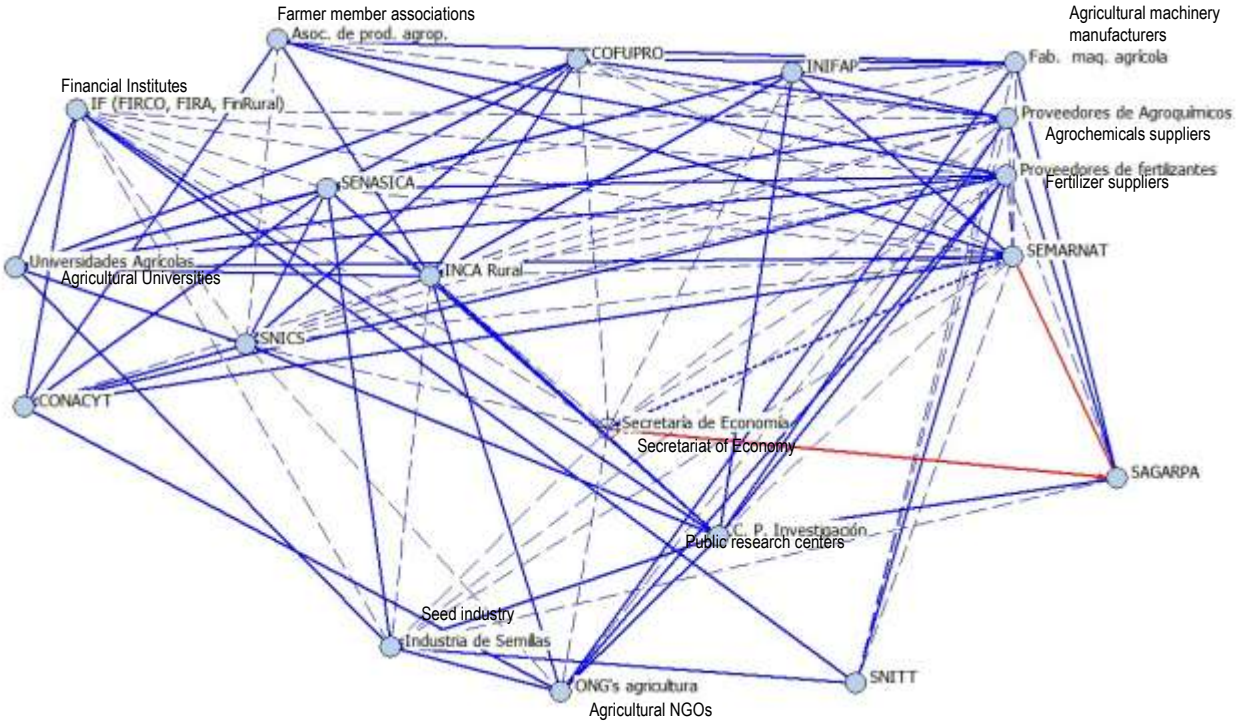


Figure 6: Organizations and institutions that maintain formal relationships
The continuous blue line shows relationships through agreements, councils and committees. The dotted blue line shows desirable but non-existent relationships

Many of the organizations and institutions establish formal relationships through policy instruments to meet purely administrative goals. However, as mentioned by the workshop participants, to operationalize the contracts or agreements reached is complicated due to limited resources and the segmentation of goals, which becomes

clear when observing the many desirable but non-existent relationships in practical terms (Figure 6).

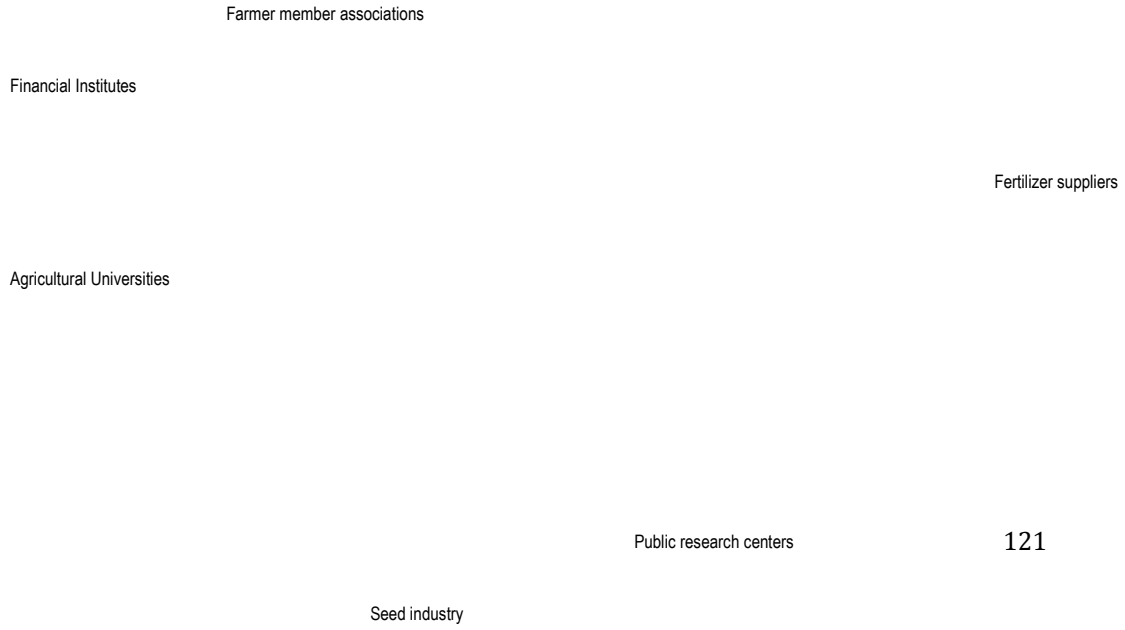
It is worth highlighting the number of desirable relationships with specialized goods and machinery suppliers that fail to materialize, confirming the distancing of public institutions regarding these members that are so relevant to the diffusion of technology.

LEVEL 3: INTERACTION BETWEEN ORGANIZATIONS IS DEVELOPING

Members who have begun to implement policy instruments or strategies fall into this category. While the level of integration and cooperation is still very new, they have begun the transition process towards closer and more systematic relationships.

Figure 7 shows the large amount of intermediate relationships in the *SNIA*, which indicates that there is a framework of standards for those relationships to succeed, but they have not yet reached significant levels of cooperation. Outstanding effort is being made by universities to make connections with rural enterprises, agricultural NGOs and public research centers to jointly provide technological solutions to improve production processes, reduce costs and improve product quality, while the Secretariat of Economy participates as a source of project financing for the development of prototypes and new technologies through its programs targeted at innovation.

The main institutions with strong relationships are *SAGARPA* and *CONACYT*. *CONACYT* has relationships with the private sector through its stimulus program for innovation, while *SAGARPA* has relationships with members of the public sector, which suggests the need to create and consolidate a public-private institutionality aimed at innovation.



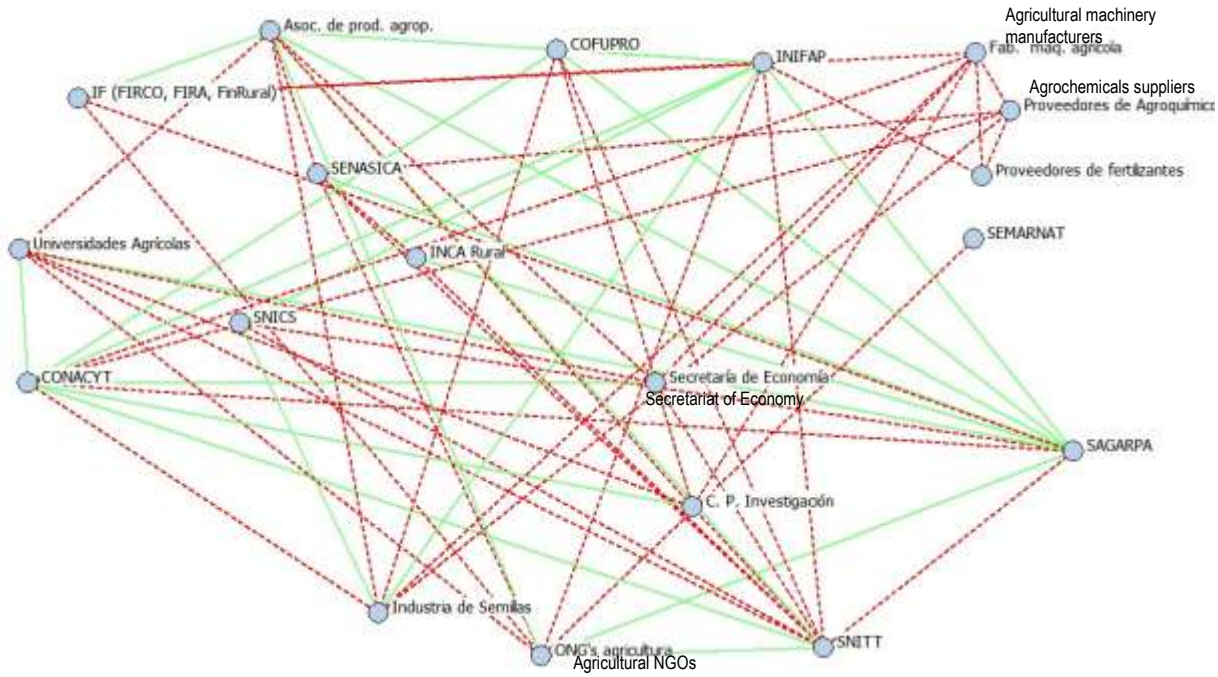


Figure 7: Relationships in development at the system's organizations and institutions
Red lines show intermediate interaction; green lines show strong relationships

Other observations of interest are as follows:

i. The sources of funding for the agricultural sector (*FIRA*, *FIRCO* or *FINRURAL*) maintain a positive relationship with public research centers and machinery manufacturers.

ii. Machinery, fertilizers and agrochemical suppliers established patterns of interaction between them to meet the needs of producers (mostly commercial) to adapt, adopt, develop and create technology solutions that are compatible with breakthrough innovations.

iii. The National Research and Technology Transfer System (*SNITT*) plays a key role in articulating efforts of universities, funding sources and science and technology demand on that part of farmer organizations and other people or groups involved in rural development.

iv. *COFUPRO* and the *Produce* Foundations should strengthen their relationships with specialized goods and machinery suppliers, and with public research centers and universities, because this shows a high concentration in members of the public and farmer associations.

v. *SENASICA* maintains relations with the rest of the components, as an important regulator of aspects related to product safety and plant and animal health.

LEVEL 4: STRONG INTERACTION

At this level the interaction between members includes the combination of financial and human resources, cooperation and feedback. Figure 8 shows how the network has a lower density. The observations that stand out are as follows:

i. Mainly public institutions and organizations combine their resources for innovation management, giving them a leading role in the system.

ii. There is a notable disconnection between goods and machinery manufacturers, and public science and technology researchers.

iii. *SAGARPA* proves to be a central agent as a source of funding, regulator and promoter of rural development projects.

iv. The role of *SNITT* is important as an intermediary between farmers' demands for technological solutions, sources of funding for research and development and public institutions responsible for this task. However, the resources that is has are limited, so it only partially fulfills its mission.

v. In terms of innovation, *SEMARNAT* has maintained a purely regulatory role, which is often at odds with the efforts of the rest of the *SNIA*.

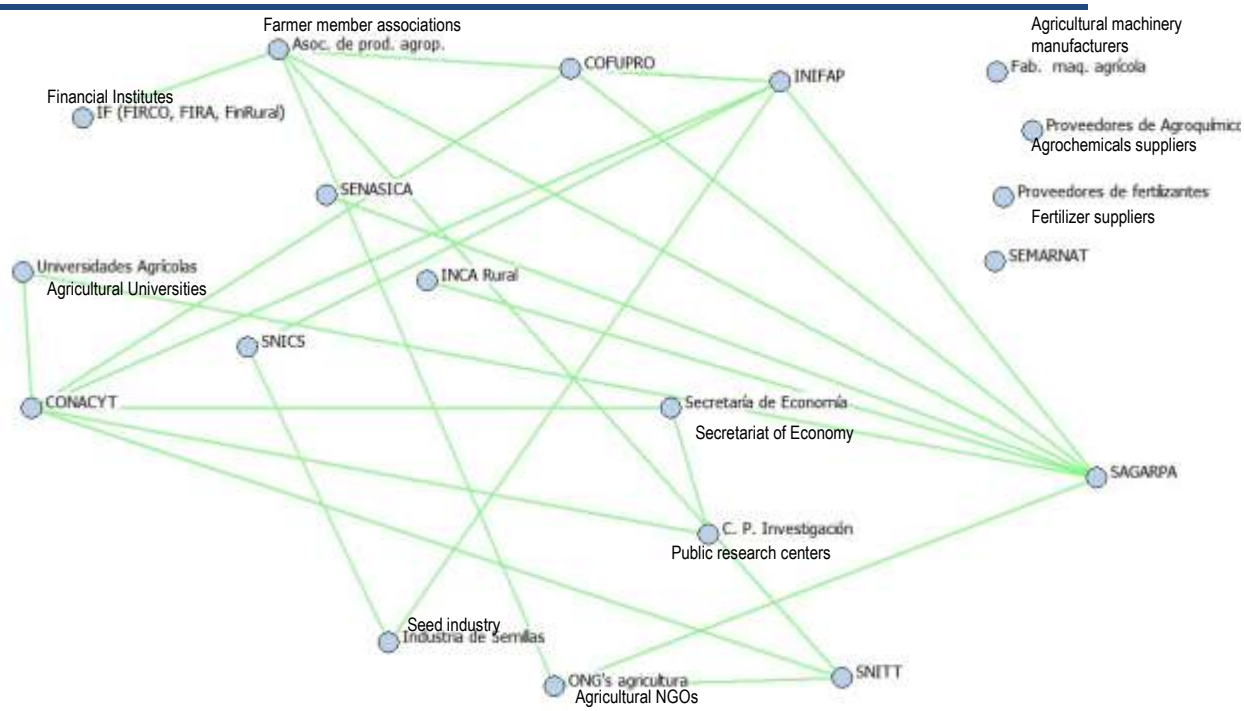


Figure 8: Cooperation between the organizations and institutions of the National Innovation System

NETWORK INDICATORS

With the information from the interaction matrix we obtained indicators to reflect the status of the *SNIA*,[68] using the software UCINET© software package (Table a). The following details can be seen below, in accordance with each level of relationship strength.

i. For this network, the density is 34.21%. This means that given the member group observed, of the total number of relationships that would complete each pair of members, just 34.21% appeared. **This confirms our view that the *SNIA* has a low level of integration.**

ii. *SAGARPA* is the most important institution in terms of output level, which is explained by being the industry leader and an important source of funding.

[68] In appendix 1 there are details of the foundations of the main indicators

However, it is not seen to be fulfilling a role as an "articulator" of the *SNIA*, which can be explained because *SAGARPA* delegates that function to authorities such as *COFUPRO* and *SNITT*, whose output levels are significantly lower.

Table 2. Output and input levels of organizations in the Mexican *SNIA*

Organization	Output level	Input level	Standardized output level	Standardized input level
SAGARPA	32	0	59.259	0
SNITT	26	4	48.148	7.407
INIFAP	19	14	35.185	25.926
Secretariat of Economy	14	0	25.926	0
SENASICA	13	8	24.074	14.815
Agricultural Universities	13	13	24.074	24.074
COFUPRO	13	8	24.074	14.815
Public research centers	12	14	22.222	25.926
SNICS	11	4	20.37	7.407
CONACYT	10	23	18.519	42.593
INCA Rural	8	5	14.815	9.259
Seed industry	7	14	12.963	25.926
SEMARNAT	6	0	11.111	0
Fertilizer suppliers	6	7	11.111	12.963
Specialized financial institutions (*FIRCO*, *FIRA*, *Financiera Rural*)	5	10	9.259	18.519
Agricultural machinery manufacturers	4	15	7.407	27.778
Agricultural producers associations	3	27	5.556	50
Agrochemicals suppliers	2	13	3.704	24.074
Agriculture-related NGOs	0	25	0	46.296

Source: Developed using data from the interactive workshop

iii. *SNITT* has a high input level, but its output is low. This can be explained by the effort made to promote articulation projects by important members, but with a low budget, which ends up limiting their impact.

iv. Education and research centers maintain a balance between their degrees of input and output, but their value is low. This can be explained by the strong interaction between "peers", but a small flow of research results to the rest of the *SNIA*.

v. The position of *INCA Rural* is marginal. This represents an important area of opportunity because as part of its duties, the institute should help to link research with production, through the coordination of outreach services.

vi. Finance agencies do not have a visible role in the *SNIA*. This is because they act with the primary mandate of providing credit, without implementing aggressive innovation support programs.

vii. The seed industry has a lower input level than output level. This is due to the commercial and private nature of this type of participant that establishes links with farmers, but very weak relationships with knowledge bidders.

viii. Similarly, machinery manufacturers, and fertilizer and agrochemicals suppliers have a marginal position in the *SNIA*. This is because of their purely commercial role, with strong interaction with their customers, but with no strong relationships with any knowledge supply.

JOINT INTERPRETATION

Despite the robust legal framework and institutional effort to articulate public and private members to trigger innovation in the Mexican agricultural sector, the efforts of *SNIA* members are not sufficiently consistent with its purposes and goals, often because they are overly ambitious in light of the available resources. Generating short-term results is often favored, but the innovation capacities of are not strengthened. This has led to resources for various programs resulting in reduced impact. The root causes are as follows:

1. Insufficient strategic articulation from *SNIA* members. The coordination efforts, rather than institutional ones, respond to the will of individuals, a situation that makes them vulnerable to long-term projects.

2. Attention to dispersed research and innovation programs, which do not translate into transcendent processes, and with verifiable territorial impact.
3. Lack of incentives for member coordination in connection with long-term projects.

Summary of conclusions from the analysis of interactions between *SNIA* members.

The *SNIA* has a low level of articulation, particularly in terms of its links with those involved in the private sector.

***CONACYT* and *SAGARPA* are central institutions as they act as policy designers and providers of resources for projects. These members have failed to generate the required coordination for the integration of the *SNIA*.**

***SNITT* is called to be an inclusive body, but does not have the required organizational resources, which leads to the formation of voids in articulation between members.**

What is required is a new work pattern with private members and more resources to serve as an incentive to create new public-private institutional arrangements that will lead to strengthening collaboration to innovate.

There are actors like *INCA Rural* and the Secretariat of Economy that should have a central role to remain on the periphery, with formal ties, but without any strong and systematic practical relationships.

Appendix 1

***SNIA* WORKSHOP**

Autonomous University of Chapingo

Texcoco, Mexico State

August 31, 2012

List of attendees

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Appendix 2

Interviewees

Pedro Tafoya, Director of *Produce* Foundation Querétaro.

Jaime Paz, Executive Secretary of *SNITT*

Dr. Aureliano Peña, Director of *SNITT* and the Autonomous University of Chapingo

Dalia de la Peña, Director of *SNITT*

Enriqueta Molina, General Director, *SNICS*

Olga Cecilia Treviño, General Director of *Semillas Treviño* and *AMSAC*

Eduardo Benítez, Director, FAO

Dr. Arnulfo del Toro, General Director of Productivity and Technology Development, *SAGARPA*

Jesús Ramírez G., Head of Department of Project Assessment and Coordination, *SNICS*

Samuel Guillén Díaz, cocoa farmer from Chiapas

Juan Carlos Deón, habanero chili farmer from Yucatán

Rómulo González, jojoba farmer from Baja California Sur

Dr. Carlos Hugo Avendaño Arrazate, Coordinator of the cocoa network, National System for Plant Genetic Resources for Food and Agriculture (*SINAREFI*)

Appendix 3. Roles of the actors of the *SNIA,* in accordance with the results of the findings workshop

Institution	Role in the *SNIA*	Current performance	Main problems	Recommendations
***SAGARPA*: mainly through its General Directorate of Productivity and Technology Development**	Supplier and/or forwarder of resources Normative Facilitator Articulator Formulates and dictates public policy	Dissolution and detachment from production sector Does not prioritize innovation Lacks long-term policies Centralized vision There is not orientation towards results, and no clear indicators It does not guarantee the implementation of public policy in the states	Annual operational logic Lack of continuity in politics Its public servants lack skills Investment is not linked to results Insufficient organizational structure for innovation to be widely dispersed	Long-term policy to implement value-generating innovations Give priority to applying innovations Align objectives and indicators with results linked to production Performance assessment of units before being given subsidies Education and training to use existing innovations
Secretariat of Economy	Generates responses for the innovation market Provides support to SMEs Authorized imports and quotas	It does not stimulate agricultural competitiveness Only monitors prices Does not encourage investment in	Notification process is bureaucratized It has not innovation policy It has no priorities regarding agro-industrial	Develop intelligence and strategic approach Define which secretariat or department agro-industry must answer to

	Encourage investment for innovation in the private sector Guides consumers, through the Federal Consumer Protection Agency (*PROFECO*)	research and innovation in the sector Has business incubation programs, giving little budget and demanding fulfillment of illusory indicators (creation of jobs and investment)	innovation	Coherence planning and cooperation with *SAGARPA* Tax incentives for innovation Clear definition of company training Create production units in transition to close to gap between formal and informal economy
Secretariat of Environment and Natural Resources (*SEMARNAT*)	Regulator for the impact on environment and sustainability Orders risk analysis and environmental impact Has the power to veto agricultural activities	Needs to comprehensively apply technical criteria for decision-making	Programs guided by handout mentality Divergent policies between *SEMARNAT* and *SAGARPA*, and skills in rural areas Duplicity	Use its scientific capacity for decision-making Carry out open announcements Give priority to production objectives, applying technical regulation criteria
National Research and Technology Transfer System (*SNITT*)	Advisory body of the Inter-Secretarial Commission Develops proposals for public research policies Coordinates and links public, private and social sectors Liaison of farmers with researchers Manages Sectoral	Links funds of the three sectors and monitors technology transfer Supports the dissemination of science and technology	Has no operating authority to reach its goals It has no legal personality, must have an agent to operate it It does not have its own budget Insufficient structure Low budget	Create the service category and define who is assigned to it Obtain recognition, authority and legal personality for it to operate Operate and support liaison between all sectors

	Fund of Agricultural Research		No liaison with executive arms	
National Seed Inspection and Certification Service (*SNICS*)	Establishes and implements the Regulatory Framework: 1. Seed certification process to offer it to farmers 2. Manages plant breeders' rights associated with new seeds. 3. The National Plant Genetic Resources	Favorable development of seed standardization It has created assessment groups Staff continuity capacity Clear strategic planning	Lack of coverage in Mexico because it has a low attention structure Lack of resources	Promote intellectual registration and plant variety protection Liaison with State Education Institutions to strengthen protection and certification processes Prepare staff More resources to encourage seed use
INCA Rural	Capacity building in the Rural Sector Executive Secretary of capacity building, technological innovation and rural outreach Accrediting body for professional services providers	Operates agreements with other agencies such as *SAGARPA* and the National Support Fund for Social Enterprises (*FONAES*), among others to provide training to professional service providers (PSPs) in a farmer attention methodology Distance education and accreditation for PSPs Professionalization towards farmers	No fixed structure Lack of resources Lack of priorities Specific needs require specific actors, which the institute does not have Has lost leadership, and its outreach services are diluted	Coordinate and strengthen links in the states, developing basic principles Public-private alliances Its role should be advisory and non-operational, to foster a network model with higher education institutions Have links to specialists to take on the role of facilitator Strengthen the

		Designs, assesses and accredits PSPs		public asset character of training and outreach services
SENASICA	Regulates and operates phytosanitary and animal health regulation Operates the records and surveillance in Mexico Exercise its power to veto the marketing of food products	Satisfactory performance in control mode	Does not have enough staff Insufficient coverage nationwide Poor relationship with *COFEPRIS* and the Secretariat of Economy	Encourage a culture of safety and quality Coordination with the Secretariat of Economy
COFUPRO	The foundations define the state innovation agendas. Encourages technological development projects Promotes technology transfer to farmers	Identifies requirements and prioritizes projects Takes on the role of resource manager for research	Political handling of agenda definition Response to pressure from interest groups. Lack of medium- and long-term planning	Identify and prioritize various farmers' requirements Balance the response to short- and long-term requirements Ensure continuity of strategic issues on the agenda
INIFAP	This is a public research institution. It does not educate or train human resources	Sells services Focuses on research, with Little attention to innovation. Technology transfer schemes with	Few resources Lack of liaison with production sectors More oriented towards Nation Researcher	A new system of performance indicators to favor the relevant research and technology transfer. More openness needed towards

		helping farmers	System requirements. Incentives that do not reward solutions to farmers' problems	collaboration and formation of innovation networks
Agricultural universities	Human resources, research and outreach	In charge of human resources Innovation is not taken on as a function	They lack effective incentives for relevant field research Ageing academic campuses Lack of willingness to work with collaboration and liaison networks Lack of management Bureaucratic procedures	Improve their participation in rural outreach Make existing knowledge available to farmers Encourage technology transfer models and creation of new businesses Effective promotion of networking
Public research centers	Research Human resources formation at graduate level Specialized technology services	They prioritize traditional research Emerging innovation work, mainly linked to companies Little approach to the agricultural sector	Little relationship with production sectors They focus more on research than innovation They lack effective liaison and technology transfer structures	Strengthen their technology transfer functions Offer solutions to problems in the agricultural sector Openness to collaboration with research institutions in the sector
National Council for Science and Technology	Establishment of science and technology policies	Most of its resources are for grants	The governing body is unbalanced and has no focus on	It must be more flexible and understand specificities of

(CONACYT)	and programs. Funding of grants and research projects Management of joint and sectoral funds.	Its management performance is good Encourages innovation support programs focused on companies with innovation experience It does not have programs aimed at the agricultural sector	innovation for the sector Needs to set priorities and financial capacity Does not act on the creation of a culture of innovation in Mexico Does not have programs to form innovation networks Abandoned relevant incentives to improve companies' willingness to invest in innovation	innovation in different sectors Contemplate longer-term innovation projects Encourage programs specific to the agricultural sector but beyond the Sectoral Fund Encourage more effective incentives for SMEs, new technology companies and farmers to invest in innovation
Seed industry	Private companies charged with the producing and marketing seeds	Covers the requirements of higher-income farmers They incorporate technical support programs for their customers	Few resources spent on research Detachment from research institutions Unaware of government support programs	Promote programs aimed at seed certification Launch effective programs to improve access to quality seeds Collaborate with national research centers
Fertilizer suppliers	Private companies charged with producing and marketing	They meet the demands of higher-income farmers They encourage	Few resources for research They depend on foreign	Promote R&D projects to create new products and clean processes

	fertilizers	demonstrative field days	technology Insufficient coverage of rural requirements Little attention to sustainability Little liaison	Collaborate with national research centers Create their own infrastructures and capacities for innovation
Agrochemicals suppliers	Private companies charged with producing and marketing insecticides and other goods	They meet the demands of higher-income farmers They offer training and technical support to their clients Through the Mexican Association of Phytosanitary Industry (*AMIFAC*), they offer programs for the prevention of agrochemicals-related accidents and pollution	They depend on technology from abroad Little investment in R&D and liaison with research centers	Promote R&D projects to create new products and clean processes Collaborate with national research centers Create their own infrastructure and capacities for innovation
Agricultural equipment and machinery manufacturers and suppliers	Private companies that import, manufacture and market equipment, machines and implements	They meet the demands of higher-income farmers They offer training, service and technical support to their clients	They lack machinery and implement design Low investment in R&D Little liaison with technology centers	Promote R&D projects to create new products and clean processes Collaborate with national research centers Create their own infrastructure and capacities for innovation

Specialized financial institutions (*FIRCO*, *FIRA*, *Financiera Rural*)	To finance projects and provide their clients with technical support	Good performance in credit offers for traditional agricultural development projects	Low coverage They do not have specific programs to finance innovations Prevailing criterion of bankers, inhibiting the participation of farmers that require funding	Design support schemes for technological innovation Create diverse financial products that meet the technological needs of the agricultural sector Create incentives for the startup of specialized technology companies in the sector
Agricultural farmer associations	Lobbying for relevant union initiatives Political negotiation on all commercial and regulatory issues	Effective in defense of union objectives	Very little attention to innovation and farmer training Patrimonialist attitude towards funds for investment in sector	Create internal units to promote and defend innovation in the sector Encourage innovation networks
Agriculture-related NGOs	To train farmers (mainly those with lower incomes)	Effective approach programs with farmer groups with low resources	Little familiarity with the formulation of innovation programs and projects Some reject new technologies	Create internal units to promote and defend innovation in the sector Act as diffusers of relevant technological innovation Promote social innovation networks

Other (specify) **CONGRESS**	To legislate in relevant terms for the sector	The Chamber of Deputies has a research center on food sovereignty	Little monitoring on policies and legal provisions related to sector innovation Unfamiliar with innovation	Assess policies and legislation for sector innovation

APPENDIX 4: *SNIA* INTERACTION MATRIX

	SAG	Secretariat of Economy	SEMARNAT	SNITT	SNICS	INCA	SENASICA	CONTPRO	INIFAP	Seed industry	Fertilizer industry	Agrochemical industry	Agricultural machinery manufacturer	Financial institutes	Farmer associations	NGOs ONGs
SAG		0	0	2	2	2	2	2	2	2	2	2	0	1	2	1
Secretariat of Economy	0		0	1	0	0	0	0	0	2	2	2	0	2	2	0
SEMARNAT	0	0		0	0	0	0	0	1	1	1	2	0	0	2	1
SNITT	2	1	0		2	2	2	2	2	2	2	2	1	2	2	1
SNICS	2	0	0	2		0	1	1	1	1	1	2	0	2	2	1
INCA	2	0	0	2	0		2	1	1	1	1	2	0	2	2	1
SENASICA	2	0	0	2	1	2		1	1	1	1	2	1	2	2	1
CONTPRO	2	0	0	2	1	1	1		2	2	2	2	1	1		1
INIFAP	2	0	1	2	1	1	1	2		2	2	2	1	1	2	1
Agricultural universities	2	2	2	2	2	2	2	2	2		2	2	1		2	2
Public research centers	2	2	2	2	2	2	2	2	2	2		2	1	2	2	2
[illegible]	2	2	2	2	2	2	2	2	2	2	2		1	2	2	1
Fertilizer suppliers	2	2	2	2	2	2	2	2	2	2	2	2		2	2	1
Agrochemicals suppliers	2	2	2	2	2	2	2	2	2	2	2	2	1		2	2
Agricultural machinery manufacturer	2	2	2	2	2	2	2	2	2	2	2	2	1	2		1
[illegible]	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Specialized Financial institutes	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Farmer associations	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Agricultural ONGs	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Measurement scale:

0: No interaction. This value is applicable when the interaction between agents is non-existent or antagonistic. 1: Formal interaction. This is when the interaction between agents is formalized by agreements, rules or laws but do not materialize. 2: Intermediate. Interaction between organizations is in development. 3: Strong. There is a relationship between agents and includes the combination of financial and human resources and cooperation and feedback.

APPENDIX 5: CONCEPTS USED

NETWORK DENSITY

The density of a network (of actors in a relationship) is the amount of relationships observed by the total amount of possible relationships, shown as a rate. To get the percentage we need to multiply this by 100.

$$D = \frac{l}{n(n-1)}$$

Where the density (D) is equal to the number of existing relationships (*l*) divided by the number of possible relationships n(n-1).

DEGREE CENTRALITY (NODE)

The centrality measures allow us to analyze the network both as a whole and individually to obtain different results: the degree of network connectivity, members with the highest and lowest number of interactions, some members in brokering relationships between other members and closeness between the members through their interactions.

The degree centrality is the number of members to which a member is directly attached and can be expressed in input level, output level and standardized degree.

Output level: *The sum of the relationships that members say they have with others.*

Input level: *The sum of the relationships members say they have with others.*

Concept 3: Description of institutions

Concept 3 complements the previous two, as it incorporates the description and analysis of the institutionality of the sector system. According to the Methodological Guide, institutions are understood as regulatory frameworks, standards and policies that regulate and provide a benchmark for their members' decisions.

What questions does this description seek to answer?

- What are the main regulatory frameworks and policies of the *SNIA* in relation to the set of policy objectives in terms of production, trading, educational, scientific, technological and innovation activities?
- What influence do these regulatory frameworks and policies have on the formation of the *SNIA* and how they contribute to innovation adding value in production systems?
- What are the strengths and weaknesses of policies and regulatory frameworks for the development of *SNIA*?

How is institutionality characterized?

As well as a brief analysis of the policies and legal frameworks, the characterization is based on identifying and indicating the most obvious effects for the *SNIA* that present incentives or disincentives for the development of the system. For evaluation, the policies and/or legal frameworks are grouped depending on the main objective pursued in two main groups, including specific sub-groups:

a. With focus on the a production basis, and includes seven sub-groups.

b. With focus on the development of *CTI*, and includes 13 sub-groups.

Each policy group is evaluated using a predetermined scale referring to their existence as a group and their practical relevance, i.e. their effectiveness to produce the expected impact on inducing innovation. At the end, there is a column for comments where clarification or specifities can be placed with more in-depth information, such as specific laws or regulations that deal with the issue, the group of members it affects, etc.

In practical terms, we must identify and indicate the most evident effects for *SNIA* of the major legal frameworks and policies that present **incentives or disincentives** for:

Farmers' acquisition of technology (innovation by modernizing): this refers to incentives and disincentives for the producer to purchase supplies, machines, software and technical support services and specialized consulting.

Investments in research and development:

- Public R&D organizations, which refer to incentives and disincentives for R&D in public research organizations for agriculture and food, including *stricto sensu* agricultural research and other forms of agriculture and food research but part of the *SNIA* (such as the processing of agricultural products, development of goods and machinery, etc.).
- Private R&D organizations, which refer to incentives and disincentives for R&D activity in private organizations (for profit or non-profit) in the same areas as described for public organizations.
- Public-private R&D, which refers to incentives and disincentives for the formation of public-private consortia, networks, projects and programs for R&D and technological and non-technological innovation.

Protection of intellectual property and technology transfer:

- Incentives and disincentives for intellectual property protection in terms of patents, trademarks, protection of cultivars, software, traditional rights over biodiversity, etc.
- It also refers to incentives and disincentives to establish technology transfer contracts.

Access to and use of biodiversity resources concerning incentives and disincentives for access and use of biodiversity resources, either for research or for productive use.

The certification of quality and product differentiation (quality seals or environmental partners): this refers to incentives and disincentives for producers to adopt quality certification or specific production features and socio-environmental production and marketing seals

Formal education and access to information (including digital information) for *SNIA* members:

- Incentives and disincentives for the formal education of farmers and the labor involved in the *SNIA.*
- This also refers to incentives and disincentives for access to digital inclusion.

Sustaining agricultural producer income (subsidies of some kind): incentives and disincentives to produce, especially for the small producer (subsidies, acquisition of production etc.).

Legal framework for innovation in the food industry

Undoubtedly, the main laws that impact the legal environment for innovation in the sector are the Rural Sustainable Development Law and the Science and Technology Law, as both contain provisions directly related to the regulation and promotion of research, inter-institutional liaison, technology transfer and incentives for researchers and inventors.

Rural Sustainable Development Law

Like other laws concerning this sector, the Rural Sustainable Development Law (*LDRS*) is constitutionally based on Section 20 of Article 27, which states:

> *"The State shall promote the conditions for comprehensive rural development in order to create jobs and ensure to the rural population welfare and participation and inclusion in national development; it will also encourage agricultural and forestry activity for optimal land use with work on infrastructure, goods, credit, training and technical support. It will also issue regulatory legislation for the planning and organizing of agricultural production, its industrialization and commercialization, considering them as public interest."*

The *LDRS* is a tool that provides extensive coverage and contemplates virtually everything related to the regulation and promotion of the sector. It establishes mechanisms for:

- Planning and coordination of rural sustainable development policy
- Federalization and decentralization
- Rural development districts
- Promotion of economic activities for rural development
- Research and technology transfer
- Training and technical assistance
- Restructuring for sustainable production
- Rural capitalization, compensation and direct payments

- Hydro-agricultural infrastructure, electrification and rural roads
- Increases in productivity, training and establishment of rural companies
- Agricultural Health
- Standardization and inspection of agricultural products and storage
- Seed inspection and certification
- Marketing
- National rural funding system
- Risk Management
- Economic and productive information
- Economic organization and product systems
- Social welfare and priority focus on disadvantaged areas
- Sustainability of rural production
- Food security and sovereignty
- National arbitration service for products offered by the rural society
- Economic support.

As can be seen, the Law is the cornerstone for the design of food and agriculture policy and of pattern of involvement of the various parties in the sector. For the latter, it gives rise to a complex institutional arrangement, which has the following elements:

- The Inter-Secretarial Commission for Sustainable Rural Development, made up of the heads of the following Federal Executive agencies: a) Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*SAGARPA*), whose head shall lead the commission; b) Secretariat of Economy (*SE*), c) Secretariat of Environment and Natural Resources (*SEMARNAT*); d) Secretariat of Finance and Public Credit (*SHCP*); e) Secretariat of Communications and Transport (*SCT*); f) Secretariat of Health (*SSA*); g) Secretariat of Social Development (*SEDESOL*), h) Secretariat of Agrarian Reform (*SRA*); i) Secretariat of Public Education (*SEP*), j) Secretariat of Energy (*SENER*), and the agencies of the executive power deemed necessary, depending on the issues in question.
- The Mexican Council for Rural Sustainable Development, as a consultative body of the Federal Government, is inclusive and representative of the interests of producers and actors of rural society. This Council shall be composed of members of the Inter-Secretarial Commission under Article 21 of this Law, representatives duly accredited by national organizations of the social and private rural sector, national agro-industrial and marketing organizations, and committees of product systems, educational and research institutions and NGOs,

in accordance with the topics to be addressed in terms of the laws and regulations in force.

- The State Council for Rural Sustainable Development.
- The Municipal Council for Rural Sustainable Development.
- The Council for Rural Sustainable Development of the Rural Development District.
- Rural Development Districts.
- Services. Public institution responsible for the implementation of programs and specific actions.
- Systems. Concurrency and coordination mechanism for the functions of the various departments and public and private agencies, where they each participate in accordance with their attributes and competencies to achieve a certain purpose.
- System-Product. The set of elements and concurrent agents of production processes of agricultural products, including the supply of technical equipment, production supplies, financial resources, primary production, collection, processing, distribution and marketing.
- Regional system-product committees.

The commitment to democracy as expressed in the Law is notable, in trying to give voice and influence to representatives from all relevant agencies. However, the number of instances created causes an enormous coordination problem that has not been fully resolved by the Inter-Secretarial Commission. In trying to translate policies into concrete actions in the field, a lack of coordination has been expressed, especially in municipalities, as several institutions offer the same services and to the same beneficiaries, while others are left without access to services or programs, creating a duplication of resources and unnecessary dispersion.

This problem is compounded by competition for resources because each entity believes that the resources available (whether financial, human and infrastructure) are insufficient to meet demand. This is aggravated by the extra efforts and resources that have to be made in order to promote and harmonize actions with the rural population.

With regard to research and technology transfer, Article 22 of the Rural Sustainable Development Law states that the Inter-Secretarial Commission, through consultation with the public sector departments and agencies and with private and

social sectors, will use institutional leverage to join, among others, the National Research and Technology Transfer System for Rural Sustainable Development (*SNITT*). To understand the scope of this mechanism, we need to refer to the definition of system in Article 3 of the Law: the *"mechanism of concurrency and coordination of the functions of the various public and private departments and bodies, where each one, in accordance with their attributions and competencies, participatesoto achieve a specific purpose".*

Article 32 of Title III states that the Executive, with the participation of federal and municipal government and social and private sectors in rural areas, shall promote economic activities in rural areas and that programs established for this purpose shall be promoted, among others, with a focus on research and agricultural technology development, technological appropriation and validation, as well as technology transfer to producers, the induction of sustainable practices and the production of improved seeds including Creole seeds.

The Law contains a chapter, number II, called "Research and Technology Transfer", which highlights the following:

> The *Inter-Secretarial Commission*[69], with the participation of the Mexican Council, will integrate the national research policy for rural sustainable development, which will be multidisciplinary and inter-secretarial, taking into account national, state and regional priorities. It will also hold programming and national coordination in this issue, taking into consideration the needs of farmers and other rural society actors.

Without specifying the mechanism, the Law mentions that, based on the relevant institutions and the use of existing resources, the national research policy for rural sustainable development will include the *measures to have a department with operational capacity, effective autonomy and moral authority* to provide any arbitral rulings and solutions that are required and will tend to have a suitable permanent diagnosis of various necessary aspects for rural sustainable development planning and technical solutions consistent with the sovereign objectives of domestic

[69] The Inter-Secretarial Commission will be made up of the heads of the following federal government agencies: a) Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food, whose head will direct it; b) Secretariat of Economy; c) Secretariat of Environment and Natural Resources; d) Secretariat of Finance and Public Credit; e) Secretariat of Communications and Transport; f) Secretariat of Health; g) Secretariat of Social Development; h) Secretariat of Agrarian Reform; i) Secretariat of Public Education; j) Secretariat of Energy; and agencies and dependencies of the Executive Power deemed necessary in accordance with the issues addressed (Article 21 of the Rural Sustainable Development Law).

production.

To stimulate the creation of research on rural sustainable development and particularly technological development, validation, transfer and appropriation by producers and others, *SNITT* was created, recognized by the Law as part of a State function performed by institutions and is induced and complemented by private and social agencies involved in this activity.

SNITT aims to coordinate and harmonize the actions of public, social and private organizations to promote and conduct scientific research, technological development, validation and knowledge transfer in the agricultural industry to identify and address problems both large domestic problems and the immediate needs of farmers and other rural society actors regarding their agricultural activities.

SAGARPA is responsible for managing the system and should include the efforts of the following parties:

- Public institutions of state and federal agricultural research.
- Public education institutions that are active in the field.
- Private research and education institutions that work in the field.
- The National Council for Science and Technology (*CONACYT*).
- The National Research System in question.
- Cooperation mechanisms with international agricultural and agro-industrial technological development research institutions.
- National and international agricultural and forestry technology-generating mechanisms, through the relevant mechanisms.
- Domestic and international organizations and individuals involved in agricultural research, through the applicable cooperation mechanisms.
- The Mexican Council for Rural Sustainable Development and the State Councils for Rural Sustainable Development.
- Other participants that the Inter-Secretarial Commission deems necessary to fulfill the purposes of the promotion of rural production.

SAGARPA is responsible for coordinating the Federal Public Administration institutions with responsibility for agricultural and socio-economic research, as well as research related to Mexico's natural resources, supporting individuals and companies to validate the technology applicable to conditions in Mexico both nationally and internationally.

According to the Law, *SNITT* is designed to meet the demands of the social and private sectors through the following actions (Art. 37):

- Addressing the needs of science and technology producers and other members of the agricultural and agro-industrial production chains, as well as non-agricultural parties involved in rural areas.
- Promoting the creation, ownership, validation and transfer of agricultural technology.
- Promoting the development of basic and applied research and technology development.
- Encouraging and stimulating socio-economic research in rural areas.
- Promoting joint research systems for rural development nationwide and within each entity and their liaison with the National Rural Training and Technical Assistance System (*SINACATRI*).
- Encourage links between agricultural research and education centers and other research institutions.
- Establishing mechanisms for social and private sectors and other parties connected to rural production to benefit and aim policies on the matter.
- Providing the means to support administrative and contentious decisions requiring judgment and arbitration.
- Promoting the relevant integration, management and updating of information on agricultural research and rural sustainable development.
- Strengthening regional and state capacities, promoting their access to research and technology transfer programs.
- Promoting the productivity and profitability of scientific research and the increase in the contribution of resources from the agricultural and industrial sectors, to conduct research relevant to the technological advancement of rural areas.
- Promoting collective and associated research and collaboration of researchers from different institutions, disciplines and countries.
- Promoting research and technology development between public and private universities and research centers to demonstrate ability to conduct research on farming and rural sustainable development.
- Using the available scientific expertise to work on specific high-priority projects, including the subjects of biotechnology, genetic engineering, biosafety and food safety.
- Facilitating productive conversion towards crops, forestry varieties and animal species that increase incomes of rural households, provide competitive advantages and promote the production of high added value.
- Developing ways to using and improving natural resources to increase environmental services and sustainable productivity.
- Promoting reliable information and criteria on the state of natural resources and the processes that determine it, and the basis for the construction of the corresponding indicators.
- Linking, as a priority, scientific research and technological development programs with the productive reconversion of economic units and regions to increase their competitive advantages and to improve the income of rural families.

With regard to *SNITT*, it is stated that in all states it will promote research and technological development, which may operate with analog organizational systems. To do this, in its expenses budget, the Special Concurrent Program must include the necessary steps to fulfill the purposes of the system, including a *research support fund*.

Moreover, the Inter-Secretarial Commission is responsible for coordinating the establishment and maintenance of mechanisms to assess and record technologies applicable to the various agroenvironmental and socio-economic conditions of farmers, addressing the productive merits, implications and restrictions of technologies, sustainability and biosecurity.

Training and outreach

The Law sets out objectives and mechanisms concerning training and outreach, with a comprehensive and holistic approach, proposing a responsibility scheme with the production sectors, which has not been difficult to achieve. As can be seen in Article 42, the objectives for *SINACATRI* are extremely ambitious. Articles 45 and 46 assigned *SINACATRI* to the role of coordinator of rural training activities, which has not been achieved, because there are many agencies involved and the duplication of efforts could not be overcome.

> **Article 41. –** Actions regarding culture, training, research, technical support and technology transfer are essential for agricultural development and rural sustainable development and are considered to be the responsibility of the three levels of government and the production sectors; such actions must be fulfilled on an ongoing basis and must be suitable for different levels of development and production and social consolidation. The Federal Government will develop a training policy through the National Rural Training and Technical Assistance System, meeting the demands of the rural population and their organizations.
>
> The training, support and technology transfer actions and programs will be formulated and implemented under the criteria of sustainability, integrity, inclusion and participation. They must link all phases of the development process, from diagnosis, planning, production, organization, processing, marketing and human development, including, in all cases, producers and various members of the rural sector, and will give priority to those who live in areas with greater economic and social disadvantages.
>
> **Article 42. -** The Federal Government will develop the training policy through the National Rural Training and Technical Assistance System, meeting the demands of the rural population and their organizations.
>
> The fundamental purposes of the Integrated Rural Training Policy, will be as follows:
>
> **I.** To develop the ability of producers to improve the performance of their agricultural and rural sustainable development activities.
>
> **II.** To boost their business skills.
>
> **III.** To facilitate the accreditation of training in accordance with the competency standards.
>
> **IV.** To give agrarian training.

V. To strengthen producers' and others' autonomy in the sector, encouraging the creation of capabilities that enable ownership of the production process and define their role in the economic and social process.

VI. To enable producers to take advantage of opportunities, as well as the knowledge of and compliance with regulations on environmental and biosecurity issues.

VII. To promote and disseminate knowledge for the best use of programs and institutional support offered in this area.

VIII. To provide producers and rural society actors with knowledge to access and actively participate in credit and financing mechanisms.

IX. To empower farmers to access information on markets and mechanisms to access them.

X. To help raise the level of education and technology in rural areas.

Article 43. - To fulfill the purposes stated in the previous article, the National Rural Training and Technical Assistance System is established as an agency for the articulation, performance and linking of capabilities that, in this area, public, private and social sectors have.

The National Rural Training and Technical Assistance System should consider the use of information and communication technologies for the fulfillment of its purposes.

Article 45.- National Rural Training and Technical Assistance System shall coordinate the following actions:

I. Develop and implement the National Rural Training and Technical Assistance System.

II. Coordinate training efforts of the various departments of the federal government with the various states, municipalities and social and private sectors organizations.

III. Improve the quality and coverage of training services.

IV. Validate training programs.

V. Monitor and evaluate training programs of public and private institutions.

VI. Support the best use of skills and resources of public, social and private entities in this area, focusing its practice in line with the National Rural Training and Technical Assistance System.

VII. Integrate the National Resource Fund for Rural Training with the resources of entities of the National Rural Training and Technical Assistance System.

VIII. Use resources to support training for the rural population.

IX. Other powers necessary to fulfill the purposes in this Law.

Article 46. - The National Rural Training and Technical Assistance System shall have the following purposes:

I. Coordinate activities of public and private institutions involved in rural training.

II. Enhance the sum of national capacity resources to achieve the aims of the Integrated

Rural Training Policy.

III. Standardize and validate the actions of different agents that undertake training for comprehensive rural development.

IV. Promote the application of certification schemes for working skills.

V. Contribute to the management of financial resources for training.

Unlike *SNITT*, *SINACATRI* has an associated service (at *INCA Rural*), which allows it to have an organizational structure and a well-defined public budget.

Article 47. - The National Rural Training and Technical Assistance System shall establish the

National Rural Training and Technical Assistance System as the level of management, programming and implementation of training and technical support.

It is important to highlight that the technical support component provided by Article 52, associated with *SENACATRI*, assigns competence in technology transfer, which would imply that there was a high degree of coordination and collaboration between this service and *SNITT*, but are located in different subsecretariats and there is no evidence that such cooperation is reaching the required level.

Article 52.- Technical assistance and education programs shall cover the following areas:

I. The transfer of basic as well as advanced forms of sustainable technology to producers and other rural development actors;

II. Implementing strategies to ensure the provision of technical services in a sustainable, efficient manner, particularly to those sectors facing greater development challenges;

III. Establishing model production units for disseminating advances in technology, facilitating their adoption and mitigating shared risks;

IV. Preserving and facilitating the re-appropriation of traditional knowledge and practices regarding sustainable use of natural resources; encouraging experience- and knowledge-sharing among *campesinos*, producers and other social actors; and strategies for drawing on and employing local knowledge while respecting the customs, ethics, traditions and technological practices of indigenous communities.

Supply Chains.

For a thorough understanding of the process of implementing this legislation, it is necessary to refer also to the concept of the **supply chain**, which the law defines as follows:

"The entire set of elements and agents involved in the process of agriculture and livestock production, including the delivery of equipment and technology, production inputs, financial capital, primary production, harvesting, processing, distribution and marketing."

In this regard, the law provides:

Article 143.- The Federal Government, working in collaboration with state and municipal authorities, shall promote and foster the development of social capital in rural areas by encouraging social and economic cooperation and organization among producers and other social actors, who have the right to associate freely, voluntarily and democratically, working to promote and sustain production-consumption chains will the goal of attaining an efficient and equitable relationship between the agents of sustainable rural development. In this regard, priority shall be given to those sectors of the population that are weakest, economically and socially, and their organizations, by means of:

I. Partnering with local community organizations to provide training and assist in implementing official programs and other policy instruments for rural development;

II. Training of specialists and administrators;

III. Promoting producer and community-based organization at all levels of rural society;

IV. Forging partnerships to encourage sustainable production and rural development;

V. Strengthening the institutional framework of producer and civic organizations;

VI. Working to improve the capability of rural organizations to engage in dialogue, negotiation and management; and

VII. Whatever additional measures are determined by the Interministerial Commission with the participation of the Mexican Council for Sustainable Rural Development.

Article 149.- The Interministerial Commission shall promote the organization of supply chains by establishing committees of the Mexican Council for Sustainable Rural Development with the participation of small and industrial-scale agriculture and livestock producers and marketers and their organizations, which shall have the following aims:

I. Coordinate the various initiatives nationwide to promote agriculture and livestock production;

II. Develop strategic plans to increase or reduce the production volume and quality of each product in accordance with market trends and domestic conditions;

III. Establish strategic alliances and agreements to improve coordination within the various supply chains;

IV. Establish measures and agreements for defining rules and procedures applicable to

commercial transactions and signing of contracts without necessitating physical inventories;

V. Participate in the determination of tariffs, quotas and import regulations; and

VI. Create mechanisms of cooperation between primary and industrial-scale producers and the various government agencies to determine the nature and quantity of products, prices, forms of payment and government assistance.

The Supply Chain Committees shall constitute mechanisms for planning, communication and ongoing cooperation between the economic actors involved in the supply chain.

The Interministerial Commission shall be responsible for promoting the smooth operation of commodity supply chains and ensuring coordination between agribusiness initiatives and market expansion and development programs. Operating through the Supply Chain Committees, the Federal Government shall promote contract farming arrangements and strategic partnerships by developing and encouraging participants to adopt contract arrangements based on established criteria regarding quality standards and reference prices.

Article 150.- There shall be a National Supply Chain Committee for each basic or strategic commodity, which shall communicate its resolutions to the Mexican Council for Sustainable Rural Development. For each supply chain there shall be a single National Committee, chaired by a representative of the agency responsible for regulating that commodity and including representatives of other relevant public agencies, representatives of producer organizations, representatives of industry and service-sector groups directly involved in the production-consumption chain and other representatives appointed in accordance with the procedural rules established by the Committee members.

Each supply chain committee shall be represented in the Mexican Council for Sustainable Rural Development by its chairperson and a non-governmental member elected by the plenum for that purpose.

Article 151.- Regional supply chain committees shall be created, with the main objective of planning and organizing production and boosting levels of production, productivity and profitability at the regional level, in accordance with state-level initiatives and the resolutions of the national supply chain committee.

Article 152.- By a vote of their members, supply chain committees may resolve to implement measures to improve and foster the development of their respective production chain within the framework of existing regulations.

The Supply Chain Committees are therefore mechanisms intended to direct and coordinate the chain of production. While their conceptual premise is noteworthy, the general spirit of the law obliges them to operate within an extremely complicated institutional framework, making it difficult to implement and

coordinate the committees so as to accommodate producers and businesses as set forth in Article 149.

Law on Science and Technology.

Published June 5, 2002, and amended June 12, 2009, and January 28, 2011, the law's main objectives are to regulate support for the promotion and advancement of science and technology research, to establish mechanisms for the State to meet its obligation to support these areas, to establish mechanisms for coordinating between various agencies and entities to develop policies and initiatives to promote science and technology development, and to establish bodies and mechanisms for coordinating with states to encourage the scientific and academic community's participation in the development of policies for the promotion, diffusion, development and application of science and technology and the training of professionals in these fields.

Article 2 cites the following public policy principles to govern the newly-formed National System of Science, Technology and Innovation:

> **I.** To increase capabilities in science, technology and innovation and promote the training of researchers and specialists in order to solve fundamental problems in Mexico, contribute to national development and improve the welfare of the population in all its aspects;
> **II.** To promote the development and integration of basic science, technological development and innovation so as to modernize and improve the quality of education, expand the frontiers of knowledge and incorporate science, technology and innovation as fundamental elements of the general culture of society;
> **III.** To incorporate technological development and innovation into the production and service sectors to foster the productivity and competitiveness that national production requires;
> **IV.** To integrate the efforts of various sectors and among both generators and users of scientific and technological understanding to advance strategic areas of knowledge critical to national development;
> **V.** To strengthen regional development through comprehensive policies aimed at decentralizing the activities of science, technology and innovation;
> **VI.** To promote participatory processes to determine the priorities, allocation and optimization of federal investment of resources in science, technology and innovation, and
> **VII.** To foster regional development through the establishment of networks and partnerships for scientific research, technological development and innovation.

The law establishes the National System of Science, Technology and Innovation. It is significant to note the secondary role assigned to private and nonprofit entities, which participate in the system "through processes of consultation, coordination and partnerships." Once again, a bias in favor of public entities is evident in the

creation of a system in which private enterprise ought to play a leading role.

Article 3.

For the purposes of this Act, the National System of Science, Technology and Innovation shall consist of:

I. Federal policy on science, technology and innovation, as determined by the General Council for Scientific Research, Technological Development and Innovation;

II. The Special Program for Science, Technology and Innovation, as well as sector-based and regional programs relating to science, technology and innovation;

III. The guiding principles and instruments for providing legislative, administrative and financial support for scientific research, technological development and innovation set forth in this Act and other regulations;

IV. The federal agencies that conduct and support scientific research, technological development and innovation, as well as private and non-profit entities and state governments through processes of consultation, coordination, participation and partnerships in accordance with this and other applicable legislation, and

V. The National Network of Research Groups and Centers and the scientific research activities of universities and institutions of higher education, in accordance with applicable provisions of their charters.

The law creates the General Council for Scientific Research, Technological Development and Innovation to serve as the coordinating and governance body, chaired by the President of the Republic and composed of the heads of the Ministries of Foreign Affairs, Finance and Public Credit, Environment and Natural Resources, Energy, Economy, Agriculture, Livestock, Rural Development, Fisheries and Food, Communications and Transportation, Public Education, and Health; the General Director of the National Council on Science and Technology (CONACYT), who serves in dual capacity as Executive Secretary of the General Council itself; the General Coordinator of the Science and Technology Advisory Forum; the President of the Mexican Academy of Sciences; a representative of the National Conference on Science and Technology; three representatives of production sector organizations with national reach and representation, to be appointed to three-year terms by the President of the Republic on the recommendation of the Economy Minister; a representative of the System of Public Research Centers, and the Executive Secretary General of the National Association of Universities and Higher Education Institutions.

Among other functions, this Council is the organ responsible for instituting policy, identifying priorities and approving the consolidated budget for science, technology and innovation. Though required to hold meetings twice a year, this seldom happens, a reflection of its low priority on the policy agenda.

On September 1, 2004, the law was amended to include the controversial Article 9b. It establishes a minimum threshold of 1% of GDP for national spending on science and technology, which today yet remains unmet.[70]

> **Article 9b.** The federal agencies and the governments of each state shall contribute to funding scientific research and technological development, pursuant to all relevant provisions on revenue and expenditures. The annual amount that public entities (federal agencies, states and municipalities) shall devote to funding scientific research and technological development through the mechanisms and instruments of assistance described in this Act shall be such that the national expenditure in this area is not less than 1% of the nation's gross domestic product.

With regard to financing mechanisms, the law states that the allocation of funding to institutions, programs, initiatives and individual recipients shall be conducted by means of competitive, equitable, efficient and transparent procedures, based on merit criteria, and directed to promote national development with a clear sense of social responsibility. Furthermore, it is stipulated that research and technological development activities conducted by public sector agencies and institutions directly shall aim to identify and resolve problems of general interest, advance the frontiers of knowledge, improve the quality of life of the population and the quality of the environment and support human resource development in these areas.

Article 13 describes the means of providing assistance to research, which include information, the Special Program for Science, Technology and Innovation, research, partnerships, financial support through sector-based and mixed funding sources and international cooperation, tax[71] and financial incentives, among others.

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[70] In 2012, the Science and Technology Advisory Forum filed a complaint "against whoever may be deemed responsible" for the violation of this article of the Law on Science and Technology.
[71] The Tax Incentive Program for technological development projects was canceled in 2009 to make way for a strategy of direct grants through the Stimulus to Innovation Program.

Article 13.

The Federal Government shall assist scientific research, technological development and innovation by the following means:

I. Gathering, processing, systematizing and disseminating information on scientific research, technological development and innovation occurring domestically or abroad;

II. Developing, implementing and revising the Special Program for Science, Technology and Innovation and other initiatives as well as the annual budgets allocated for these areas by various federal agencies;

III. Research activities in science, technology and innovation conducted by the federal agencies;

IV. Resources accorded through the federal government's annual expenditure budget to institutions of higher education and subsequently allocated to scientific or technological research activities according to the programs and internal governance of these institutions;

V. Partnering science and technology education with the production and service sectors;

VI. Supporting and strengthening science and technology research conducted at public institutions of higher education, which shall govern their activities in accordance with principles, plans, programs and internal rules provided under their specific regulations;

VII. The creation, financing and operation of the funds described in this Act, and

VIII. Educational programs and standards, tax incentives, financial stimuli, administrative and trade preferences and the safeguarding of intellectual property, in accordance with international treaties and specific legislation applicable to these areas.

The legislation aims to encourage the coordination and decentralization of scientific and technological research activities, and accordingly creates the National Network of Research Groups and Centers. Various collaborative networks have arisen out of the latter, but the working model envisioned is still far from being realized.

Article 30. CONACYT shall promote the formation and operation of a National Network of Research Groups and Centers. This Network shall have the task of defining joint strategies and programs, determining actions, developing human and financial resources, improving infrastructure, fostering exchanges and concentrating efforts in areas of interest to national development, as well as studying strategies and formulating programs to encourage research as a profession, strengthen and increase the number of research organizations and encourage interactions between them; propose the creation of new groups and centers and create knowledge networks in strategic areas.

The law creates the National Conference on Science and Technology as a

coordinating body between CONACYT and state-level entities (the state councils on science and technology) to promote and support science and technology research and participate in developing policies and initiatives in these areas. It also creates the Science and Technology Advisory Forum as a permanent, independent body to advise the President, the General Council and CONACYT's governing board and serve as the voice of the scientific and academic community, developers of technology and production sector, formulating policy proposals and initiatives in the field of scientific research, technological development and innovation. The Forum is composed of scientists, technology professionals, businesspeople and representatives of national, regional and local organizations, both public and private, recognized for their ongoing contributions to scientific research, technological development and innovation, and who participate, save in specified exceptions, on a voluntary and unpaid basis.

The law gives priority to partnerships between higher education institutions and public research centers and the production sector, and lays out a framework for creating Knowledge Transfer Partnership Units, which may be internal or external and constituted under a wide variety of legal frameworks, allowing the institutions to create foundations, trusts or companies for marketing services and technologies. Furthermore, by allowing academic personnel of the institutions to be hired for the project, it establishes a framework for offering additional income to researchers contracted to conduct research or provide technology services.

> **Article 40.** With respect to the creation and operation of the promotional means described in this Act, priority shall be given to those projects directed at promoting modernization, innovation and technological development linked associated with companies and organizations that use technology, especially small and medium-sized enterprises.
>
> Likewise, priority shall be accorded to projects aiming to facilitate a rational, more efficient and ecologically sustainable use of natural resources, partnerships for creating and sustaining scientific and technological networks, and initiatives for linking scientific and technological research with the production and service sectors with the potential to improve the productivity and competitiveness of domestic industry.
>
> To obtain support for the technological research activities described in this article, proposals must include a formal declaration of interest in the technology's applications from the potential user(s). Furthermore, except in duly justified cases, the project's beneficiaries must contribute resources toward meeting its total financing needs.
>
> The assistance described in this article shall be granted for a fixed period determined in

accordance with the content and aims of the proposal; this support shall be suspended if it is determined that the project is no longer technically or economically viable.

Article 40b. Universities and public institutions of higher education and Public Research Centers may create knowledge transfer partnership units.

These initiatives may be established under the legal framework best suited to their objectives, in accordance with applicable statutes and regulations, provided they do not operate as state-owned enterprises. Additionally, such projects may contract academic personnel from universities and higher education institutions, as well as Public Research Centers pursuant to the provisions of Articles 51 and 56 of this Act.

Under no circumstances may the units described in this article fund their operating expenses with public resources. The public resources they receive pursuant to the provisions of this Act shall be dedicated exclusively toward developing and operating technological development and innovation projects and promoting linkages with the production and service sectors.

An additional incentive for researchers at public research centers is established in Article 51, which provides a framework for sharing up to 70% of technologies' licensing proceeds with their inventors or creators. Researchers may also participate in the formation of tech start-ups. Furthermore, the legislation enables research centers to participate in partnerships, joint ventures and innovation networks.

Article 51.

Public Research Centers shall promote, with the joint involvement of the public and private sectors, the formation of strategic partnerships, technological alliances, consortia, knowledge transfer partnership units, new, technology-based private companies and regional innovation networks, with the objective of incorporating both technologies and innovations developed at these research centers as well as the researchers trained in them.

In relation to the provisions of the preceding paragraph, the governing bodies of the public research centers shall determine and resolve the following:

I. The guidelines and basic conditions of the partnerships, alliances, consortia, units, networks or new companies involving the center's participation, with or without a capital contribution to the companies concerned, and

> **II.** The terms and conditions governing the participation of the center's employees in the partnerships, alliances, consortia, units, networks or new companies concerned.
>
> In addition, the governing bodies of the public research centers may provide support and establish criteria under which the center's employees may participate in incubator programs for innovative technology businesses in conjunction with the center and with third parties, when appropriate.
>
> The terms, conditions and criteria described in Item II and the preceding paragraph shall be established by the Centers' governing bodies by means of general rules issued for this purpose, consisting of precautionary measures designed to prevent the Centers' employees from engaging in situations of conflict of interest as described in Articles 8, Item XII, and 9 of the Federal Law on Administrative Responsibilities of Public Servants. Prior to issuance, these rules shall be subject to review by the Center's internal control unit.
>
> The governing bodies shall also determine the pertinent aspects concerning intellectual property rights and benefits accruing to the public research center in relation to the provisions of this article.
>
> To promote the commercialization of the centers' intellectual and industrial property rights, the governing bodies shall pass guidelines allowing the academic personnel responsible to claim up to 70% of the royalties generated.

As should be apparent, the law creates a flexible framework for partnering research activities with industry, together with financial incentives to academics and researchers participating in the commercialization of technologies and services.

Industrial property

Industrial property.

Mexico has not failed to keep pace with international developments with respect to the protection of intellectual property rights in living matter. Market pressures first led to revisions to the Law on Inventions and Trademarks in 1987, which signified a first step toward lifting the ban on patenting chemicals, agrochemicals, pharmaceutical chemicals, pharmaceuticals and food products and which also included biotechnology products. With the signing of the North American Free Trade Agreement, Mexico amended its laws on intellectual property, technology transfer and foreign investment.

Thus, in 1991, Mexico passed the Law for the Promotion and Protection of Industrial Property, which expressly recognized the patentability of such products, included protection of trade secrets and made trade in technology possible. With respect to

biotechnology, this law included plant varieties as patentable subject matter (contrary to the international position on this issue) and excluded genetic material as found in nature. In 1994, the law was amended and renamed the Industrial Property Law. Under these revisions, the following were excluded from patentability (Article 16): a) essentially biological processes for the production, reproduction and propagation of plants and animals; b) biological and genetic material as found in nature; c) animal breeds; d) the human body and the living parts thereof; and e) plant varieties, which were to be protected under a *sui generis* system.

Additionally, Article 19 states, "The following shall not be considered inventions for the purposes of this Act:

> **I.-** Theoretical or scientific principles;
>
> **II.-** Discoveries which consist in making known or disclosing something which already existed in nature, even though it was previously unknown to humanity;
>
> **III.-** Diagrams, plans, rules and methods for performing mental acts, games or business and mathematical methods;
>
> **IV.-** Computer programs;
>
> **V.-** Forms of presentation of information;
>
> **VI.-** Aesthetic creations and artistic or literary works;
>
> **VII.-** Methods of surgical or therapeutic treatment or diagnosis applicable to the human body and to animals; and
>
> **VIII.-** Juxtaposition of known inventions or mixtures of known products, their variation in use, form, dimensions or materials, except where in reality there is a combination or merger such that they cannot function separately or the characteristics or functions thereof are modified in order to obtain an industrial result not obvious to a person skilled in the art.

The requirement of a deposit of biological material to complement the description of the invention, in the case of inventions related to living matter, is established as follows:

> **Article 47.-** The patent application shall be accompanied by:
>
> **I.-** A description of the invention, which shall be sufficiently clear and complete to be fully understood and where appropriate to serve as a guide for a person with average skill in the art to make it; it shall also mention the best method known to the applicant of carrying out the invention when this is not clear from the description thereof. In the case of biological material where the description of the invention cannot itself be sufficiently detailed, the

application shall be completed with a record of the deposit of the material at an institution recognized by the Institute, in accordance with the provisions of the regulations under this Act;

II.- The drawings required for the understanding of the description;

III.- One or more claims, which shall be clear and concise and may not exceed the contents of the description; and

IV.- An abstract of the description of the invention, which shall serve solely for the publication thereof and as an element of technical information.

Confidential information, in turn, may be protected under the trade secret provisions described in the following articles:

Article 82.- Any information susceptible of industrial or commercial application that a natural person or legal entity keeps, is of confidential character and is associated with securing or retaining a competitive or economic advantage over third parties in the conduct of economic activities, and regarding which the said person or entity has adopted sufficient means or systems of preserving confidentiality and restricting access, shall be considered a trade secret.

The information constituting a trade secret shall necessarily relate to the nature, characteristics or purposes of products, to production methods or processes or to ways or means of distributing or marketing products or rendering services.

Information that is public domain, is evident to a person skilled in the art on the basis of previously available information or must be disclosed by virtue of a legal provision or court order shall not be considered a trade secret. Information that is supplied to any authority by a person possessing it as a trade secret shall not be considered public domain or to be disclosed by virtue of a legal provision when it is supplied for the purpose of obtaining licenses, permits, authorization, registrations or any other official documents.

Article 83.- The information referred to in the foregoing Article shall consist of documents, electronic or magnetic media, optical discs, microfilm, film or other similar material.

Article 84.- The person who keeps a trade secret may transfer it to or authorize its use by a third party. The authorized user shall be under the obligation not to disclose the trade secret by any means.

In agreements under which know-how, technical assistance and basic or detailed engineering are provided, confidentiality clauses may be included to protect any trade secrets that may form part of such services, and the said clauses shall specify the aspects to be treated as confidential.

Article 85.- Any person who, by reason of his work, employment, function or post, the practice of his profession or the conduct of business relations, has access to a trade secret the confidentiality of which he has been warned of shall abstain from revealing it without

just cause and without the consent of the person keeping the said secret or of the authorized user thereof.

Article 86.- Any natural person or legal entity engaging either a worker who is working or has worked for, or a professional, adviser or consultant who is rendering or has rendered his services on behalf of another person or entity with a view to obtaining trade secrets from the latter, shall be liable for payment of damages for any prejudice caused to that person or entity.

Any natural person or legal entity who by any unlawful means obtains information constituting a trade secret shall likewise be liable for the payment of damages.

Article 86b.- The information required by special laws to determine the safety and efficacy of pharmaceutical and agricultural chemicals that make use of new chemical compounds shall be protected in terms of the international treaties to which Mexico is party.

Protection of new plant varieties

In October 1996, with the Federal Law on Plant Varieties, Mexico established a legal basis for the protection, commercialization and promotion of innovation in seeds and plant matter. It also became a party to international agreements in this field by depositing its instrument of accession to the UPOV Act of 1978. The current system of plant variety protection includes all species and is a powerful incentive for the transfer of new technologies by allowing the protection of domestic and imported materials while establishing an environment conducive to access to international markets, according to the provisions of the following articles:

Article 4.- The rights granted to plant breeders by this Act shall be the following:

I.- Recognition as the breeder of a plant variety, which right shall be inalienable and imprescriptible; and

II.- Utilization and exploitation of the plant variety and the propagating material thereof, either themselves or by third parties with their consent, exclusively and for a limited period, with a view to production, reproduction, distribution or sale, and also with a view to the production of other plant varieties and hybrids for commercial purposes. The term of these rights shall be:

a) Eighteen years for perennial species (forest and fruit trees, vines, ornamentals) and their rootstocks; and

b) Fifteen years for species not included in the foregoing subparagraph.

The above periods shall be calculated from the date of grant of the breeder's certificate and, when they have expired, the plant variety and its utilization and exploitation shall become public property.

Article 5.- The consent of the breeder of a plant variety shall not be required for the use thereof:

I.- As a source or research material for the genetic improvement of other plant varieties;

II.- In the multiplication of propagating material insofar as it is intended for personal use as grain for consumption or seed for sowing, in accordance with the regulatory supplement of this Act and Mexican official standards enacted by the Secretariat, or

III.- For human or animal consumption for the exclusive benefit of the person harvesting it.

Article 7.- A plant breeder's certificate shall be granted where the plant variety is:

I.- New; the plant variety or the propagating material thereof shall possess this characteristic when:

a) It has not been the subject of disposal on the national territory, or has not been the subject of such disposal for a year prior to the filing date of the application for a breeder's certificate; and

b) It has not been the subject of disposal abroad, or has not been the subject of a disposal abroad for six years prior to the filing of the application in the case of perennials (vines, forest and fruit trees and ornamentals), including their rootstocks, and for four years prior to the filing of the application in the case of all other species.

For the purposes of subparagraphs a) and b) above, no account shall be taken of such disposals as may have taken place without the consent of the breeder of the plant variety to be protected;

II.- Distinct; the plant variety shall possess this characteristic where it is technically clearly distinguishable by one or more relevant characteristics from any other variety known to exist at the time of the application for protection; such characteristics shall be susceptible of precise recognition and description. The regulatory supplement shall specify the various criteria that determine whether or not a variety is known;

III.- Stable; the plant variety shall possess this characteristic where it retains its significant characteristics unchanged after successive acts of reproduction or propagation;

IV.- Uniform; the plant variety shall possess this characteristic where its significant characteristics are sufficiently uniform, subject to the expected variation attributable to its reproductive or vegetative propagation.

Article 9.- The application for a breeder's certificate shall propose a variety denomination, which, to be approved, shall be different from any other existing in the country or abroad, shall comply with the other requirements laid down in the regulations under this Act and

shall not be identical or confusingly similar to one previously protected under the Industrial Property Law. The application shall specify the parentage and origin of the plant variety.

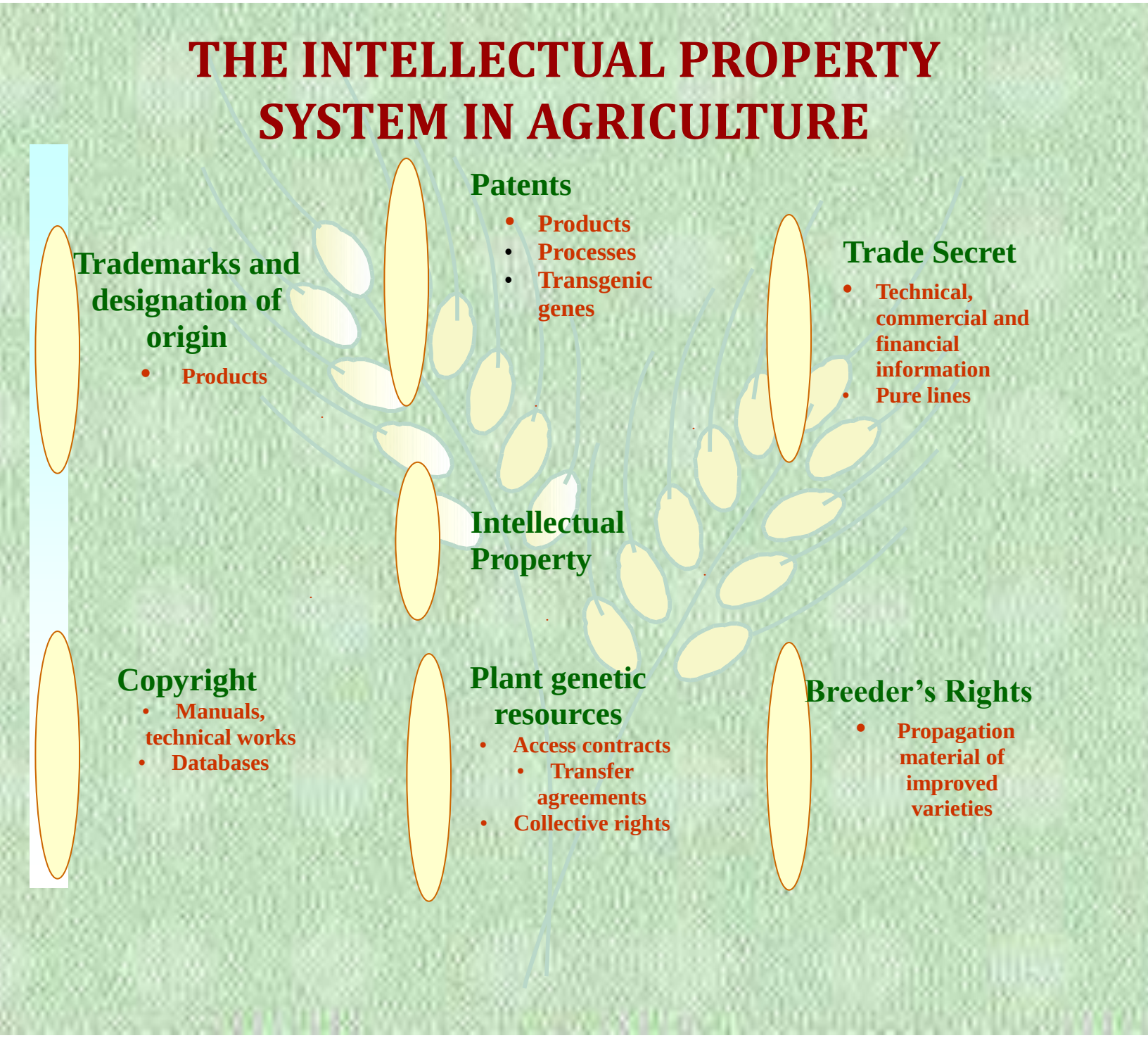
Where the proposed denomination does not meet the foregoing requirements, the Secretariat shall refuse it and demand that the applicant propose another within a non-renewable period of 30 calendar days.

With this legislation, Mexico managed to complete its system of intellectual property protection[72] in accordance with international trends and the international treaties to which Mexico is party, thereby seeking to promote and encourage domestic innovation as well as technology transfer and development. Currently, a patent may be obtained for virtually any invention, including microorganisms, transgenic animals and plants, components of living organisms and the uses thereof, as well as biological material in purified and isolated form. Accordingly, **the protection of intellectual property in Mexico is an incentive to attract technology and investment.**

Figure 1 clearly shows the possibilities of intellectual property protection in Mexico in this sector.

[72] In 1996, a new Federal Copyright Law was passed as well.

Figure 1.


THE INTELLECTUAL PROPERTY SYSTEM IN AGRICULTURE
Patents
Products
Processes
Transgenic genes
Trademarks and designation of origin
Products
Trade Secret
Technical, commercial and financial information
Pure lines
Intellectual Property
Copyright
Manuals, technical works
Databases
Plant genetic resources
Access contracts
Transfer agreements
Collective rights
Breeder's Rights
Propagation material of improved varieties

Government agencies related to intellectual property protection in Mexico

Mexican Institute of Industrial Property (IMPI)

The Mexican Institute of Industrial Property is a public agency operating under the Secretariat of Economy[73] and charged with overseeing the industrial property regime in Mexico.

Under the overhaul of the Law for the Promotion and Protection of Industrial Property undertaken in August 1994, the Institute was made the administrative authority in this field. The Industrial Property Law assigns it the following responsibilities:

- Provide protection by means of patents, utility model registrations and industrial designs; trademarks and advertisements and publication of commercial names; authorize the use of denominations of origin and protect trade secrets-
- Prevent and combat violations of industrial property rights and acts of unfair competition, and apply appropriate sanctions
- Promote the creation of industrially applicable inventions, best techniques and the diffusion of technological knowledge in the production sectors, encouraging technology transfer to assist companies in making use of the latest technology by disseminating document archives with information on technology contained on electronic media, microfilm and paper, as well as the situation of industrial property rights abroad
- Promote international cooperation through the exchange of administrative and legal experience with institutions responsible for the registration and legal protection of industrial property abroad.

National Seed Inspection and Certification Service (SNICS)

[73] It is a decentralized institution with independent resources and administrative powers.

The National Seed Inspection and Certification Service (SNICS) is a decentralized agency of the Secretariat of Agriculture (SAGARPA) that has been responsible for certifying the quality of agricultural seed for over 30 years. It is also the agency responsible for reviewing applications for plant breeder's rights protection and coordinating policies for the conservation, management and ensuring access to plant genetic resources for food and agriculture.

National Copyright Institute

The National Copyright Institute (INDAUTOR), as a decentralized agency of the Secretariat of Public Education under the Office of the Deputy Minister for Higher Education and Scientific Research, is the administrative authority on copyright and related rights. Among other functions, it maintains the Public Copyright Registry and is responsible for obtaining amicable settlement through conciliation of persons who are in conflict on any matter related to copyright or related rights.

Biosafety. *The Law on Biosafety of Genetically Modified Organisms*

On March 18, 2005, after a process of deliberation lasting more than three years, Mexico enacted the Law on Biosafety of Genetically Modified Organisms, undoubtedly the most important legal instrument for regulating the use of biotechnology:

> **ARTICLE 4.-** The provisions this Act shall regulate the biosafety of all GMOs obtained or produced through the application of modern biotechnology techniques described herein and utilized for purposes related to agriculture, livestock, fisheries, forestry, industry, commerce, bioremediation, or for any other purpose, with the exceptions stipulated in this Act.
>
> **ARTICLE 5.-** The provisions of this Act shall also regulate the authorization for marketing or importation for marketing of GMOs intended for human use or consumption or for processing into foods for human consumption. Additionally, this Act shall also regulate the authorization of GMOs besides those just mentioned, which are intended for uses related to public health or bioremediation.
>
> **ARTICLE 6.-** The following shall be excluded from the scope of this Act:
>
> **I.** Use under confinement, experimental release, release within a pilot program and commercial release, marketing, importation and exportation of GMOs, when the genetic modification of such organisms is obtained through traditional mutagenic or cellular fusion techniques, including the fusion of plant cell protoplasts, where the resulting organisms may also be produced with traditional multiplication methods or *in vivo* or *in vitro* cultures, provided these techniques do not require the use of genetically modified organisms as receptor or parental organisms;

II. The use of *in vitro* fertilization techniques, conjugation, transduction, transformation or any other natural process, as well as polyploidy induction, provided these do not employ recombinant deoxyribonucleic acid (DNA) molecules or genetically modified organisms;

III. The production and processing of medicines and pharmacological agents with GMOs created by confined processes which are regulated under the General Health Law;

IV. Public health regulation of GMO-derived products and confined production processes involving GMOs authorized under this Act intended for human or animal use or consumption. These products and processes are subject to the provisions of the General Health Law and its regulatory supplement applicable to all products and processes;

V. The human genome, human stem cell cultures, modification of human stem cells and the biosafety of hospitals, which are regulated in accordance with the General Law of Health and the international treaties to which Mexico is a signatory;

VI. The collection and exploitation of biological resources regulated under the General Law on Ecological Balance and Environmental Protection, the General Wildlife Law and international treaties to which Mexico is a signatory; and

VII. The intellectual property rights of biotechnology products and processes, which fall within the scope of the Industrial Property Law, the Federal Law on Plant Varieties and the international treaties to which Mexico is a signatory.

It is very important to highlight the provisions of Article 6, Item IV. By leaving products containing GMO derivatives to the oversight of conventional public health authorities, the LBGMO exempts thousands of processors of foods that contain GMOs but do not reflect any evidence of modification in the final product. Thus, only GMOs *per se* are subject to regulation under the LBGMO.

One of the major areas of legal uncertainty existing prior to the LBGMO concerned the regulatory responsibilities of each agency. This legislation clearly articulates which federal agency is responsible for administering each area of oversight:

ARTICLE 10.- The authorities responsible for biosafety monitoring shall be the following:

I. SEMARNAT (Secretariat of Environment and Natural Resources);

II. SAGARPA (Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food), and

III. SSA (Secretariat of Health).

The SHCP (Secretariat of Finance and Public Credit) shall undertake the responsibilities described in this Act in relation to the importation of GMOs and products containing GMOs.

ARTICLE 11.- SEMARNAT shall undertake the following responsibilities with respect to all types of GMOs, except those falling under the regulatory authority of SAGARPA:

I. Participating in the formulation and enforcement of general policies on biosafety;

II. Analyzing and evaluating, on a case-by-case basis, the possible risks that activities involving GMOs may pose to the environment and biodiversity, based on risk assessments and reports of results drafted and submitted by the interested parties in accordance with the provisions of this Act;

III. Approving and issuing permits for activities involving GMO release into the environment, as well as establishing conditions and precautionary measures to which these activities must adhere and monitoring compliance, in accordance with the provisions described herein, including the release of GMOs for purposes of bioremediation;

IV. Monitoring the effects that GMO release, permitted or accidental, may have on the environment and biodiversity, in accordance with the provisions of this Act and the Mexican official standards derived therefrom;

V. Participating in the drafting and publication of the lists described in this Act;

VI. Decreeing the suspension of permits when there is scientific and technical evidence to suggest that the permitted activity poses more significant risks than those previously foreseen, and may negatively affect the environment, biodiversity or the health of humans, animals, plants or marine life. A determination in respect to the latter criterion shall be made based on the express recommendation of SAGARPA or the SSA, in accordance with the scopes of their respective responsibilities under this Act, supported by technical and scientific evidence;

VII. Enacting and enforcing the appropriate security measures or expedited measures, based on scientific and technical evidence and the precautionary principle, in the terms of this Act;

VIII. Performing inspections and monitoring compliance with this Act, the regulatory supplement and the Mexican official standards derived from it;

IX. Imposing administrative sanctions on persons violating the precepts of this Act, the regulatory supplement and the Mexican official standards derived from it, without detriment, in a determined case, to the corresponding punishments when the acts or omissions result in crime, as well as the consequent civil and environmental responsibility; and

X. Other faculties that this Act confers to SEMARNAT.

ARTICLE 12.- SAGARPA shall exercise the faculties conferred to it by this Act when they concern activities with GMOs in the following cases:

I. Plants that are considered agricultural specimens, including seeds and any other organism or product considered within the realm of application of the Federal Law on Plant Health, with the exception of wild and forest specimens regulated by the General Law on Wildlife

and the General Law for Sustainable Forestry Development, respectively, and those that lie within any protection regime in accordance with the Mexican official norms derived from these laws;

II. Animals that are considered livestock and any other considered within the field of application of the Federal Law on Animal Health, with the exception of wild species regulated by the General Law on Wildlife and those that lie within any protection regime in accordance with the Mexican official standards derived from these laws;

III. Animal or plant health and nutritional inputs;

IV. Fish and marine life, with the exception of those that lie within any protection regime in accordance with Mexican official standards;

V. GMOs used for immunization to protect against and prevent the spread of animal diseases;

VI. GMOs that are fungi, bacteria, protozoans, viruses, viroids, spiroplasms, phytoplasms and other microorganisms that have agriculture, livestock, fishing, marine life or plant and animal health applications; and

VII. Additional species and products described in the regulatory supplement to this Act.

ARTICLE 13.- In the cases established in the previous article, it corresponds to SAGARPA to exercise the following attributions:

I. Participating in the formulation and enforcement of general policies on biosafety;

II. Analyzing and evaluating, on a case-by-case basis, the possible risks that activities involving GMOs may pose to the health of animal, plant and aquatic species, as well as to the environment and to biodiversity, based on risk assessments and reports of results drafted and submitted by the interested parties in accordance with the provisions of this Act;

III. Approving and issuing permits for activities involving GMOs, as well as establishing conditions and precautionary measures to which these activities must adhere and monitoring compliance, in accordance with the provisions described herein;

IV. Monitoring the effects that GMO release, permitted or accidental, may pose to the health of animal, plant and aquatic species, as well as to the environment and to biodiversity, in accordance with the provisions of this Act and the Mexican official standards derived therefrom;

V. Participating in the drafting and publication of the lists described in this Act;

VI. Decreeing the suspension of permits when there is scientific and technical evidence to suggest that the permitted activity poses more significant risks than those previously foreseen, and may negatively affect the health of animals, plants or aquatic species, biodiversity or human health. A determination in respect to the latter two criteria shall be made based on the express recommendation of SEMARNAT or the SSA, in accordance with

the scopes of their respective responsibilities under this Act, supported by technical and scientific evidence;

VII. Enacting and enforcing the appropriate security measures or expedited measures, based on scientific and technical evidence and the precautionary principle, in the terms of this Act;

VIII. Performing inspections and monitoring compliance with this Act, the regulatory supplement and the Mexican official standards derived from it;

IX. Imposing administrative sanctions on persons violating the precepts of this Act, the regulatory supplement and the Mexican official standards derived from it, without detriment, in a determined case, to the corresponding punishments when the acts or omissions result in crime, and to the civil responsibility that may result; and

X. Other attributions conferred by this law.

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ARTICLE 14.- In cases when the knowledge, administrative procedures and resolution of a permit application concerning wild and forest species correspond to SEMARNAT, this institution must send the respective file to SAGARPA so the latter may issue its corresponding opinion.

ARTICLE 15.- In cases when SAGARPA has competence, SEMARNAT will be concerned with the following:

I. Issuing the corresponding biosafety recommendation prior to SAGARPA's resolution of the application, as the result of an analysis and assessment of the risks based on the study undertaken and presented by the interested parties, in relation to the possible risks that the activity with GMOs may cause to the environment and to biodiversity, in cases dealing with applications for permits for the experimental release of such organisms, or based on the reports of results and the supplemental information provided by the interested parties together with the permit applications for the release within a pilot program and for commercial release;

II. Requesting SAGARPA to suspend the effects of permits that the latter Secretariat has issued, when there is scientific and technical evidence to suggest that the permitted release poses more significant risks than those previously foreseen, and may negatively affect the environment or biodiversity; and

III. The exercise of the faculties described in Article 11, Items I, II, IV, V, VII and VIII of this Act.

The biosafety recommendation described in Item I of this article shall be obligatory and binding, prior to the granting of the permits whose issuance corresponds to SAGARPA, and shall be issued in accordance with the provisions of Article 66 of this Act.

ARTICLE 16.- The SSA shall exercise the following faculties in relation to GMOs:

I. Participating in the formulation and enforcement of general policies on biosafety;

II. Evaluating, on a case-by-case basis, the studies drafted and submitted by the interested parties regarding the safety and potential risks of GMOs subject to authorization under the provisions of Title Five of this Act;

III. Approving and issuing the GMO authorizations described in the previous item;

IV. Participating in the drafting and publication of the lists described in this Act;

V. Enacting and enforcing the appropriate security measures or expedited measures, based on scientific and technical evidence and the precautionary principle, in the terms of this Act;

VI. Requesting SEMARNAT or SAGARPA, as appropriate, to suspend the effects of permits that the latter Secretariat has issued, when there is scientific and technical evidence to suggest that the activity authorized by either of these Ministries poses more significant risks than those previously foreseen and may negatively affect human health;

VII. Performing inspections and monitoring compliance with this Act, its regulatory supplement and Mexican official standards;

VIII. Imposing administrative sanctions on persons violating the precepts of this Act, the regulatory supplement and the Mexican official standards derived from it, without detriment, in a determined case, to the corresponding punishments when the acts or omissions result in crime, and to the civil responsibility that may result; and

IX. Other faculties that this Act confers.

The SSA will undertake health and epidemiological vigilance activities related to GMOs and products containing or derived from GMOs, in accordance with the General Health Law and its regulatory supplement.

ARTICLE 17.- In the event of accidental release of GMOs, the Ministries will act in coordination so that, in the fields of their respective competencies according to this Act, they may implement appropriate measures to avoid negative consequences to biodiversity, human health or the health of animal, plant and marine species, as the case shall be.

ARTICLE 18.- The SHCP shall exercise the following faculties with respect to the importation of GMOs and products containing them:

I. Inspecting, during passage through customs upon entering national territory, GMOs imported and intended for release into the environment or for purposes described in Article 91 of this Act, and which have been granted the required permit and/or authorization, as appropriate, under the terms of this legislation;

II. Ensuring that the documentation accompanying GMOs imported into Mexico contains the identification requirements described in the Mexican official norms derived from this Act;

III. Participating, in conjunction with the Ministries, in the issuance of Mexican official norms regarding storage or deposit of GMOs or products containing GMOs in customs enclosures upon entering national territory;

IV. Immediately notifying SEMARNAT, SAGARPA and/or the SSA, regarding possible infractions of the precepts of this Act with regard to import of GMOs; and

V. Refusing entry into national territory of GMOs and products containing GMOs in cases where said organisms and products have not been issued the permit and/or authorization, as appropriate, required for their import in accordance with this Act.

The SHCP shall exercise the above faculties without detriment to the ones conferred by customs legislation in relation to the general importation of goods.

With respect to proposed release into the environment, the LBGMO establishes a permitting process based on the "step-by-step" principle, as described below:

ARTICLE 32.- A permit shall be required to undertake the following activities:

I. Experimental release into the environment, including the importation of one or more GMOs for this purpose;

II. Environmental release within a pilot program, including the importation of GMOs for this purpose; and

III. Commercial release into the environment, including the importation of GMOs for this purpose.

The second principle on which the LBGMO is based is "case-by-case" risk assessment, establishing a very rigorous procedure to be followed for the issuance of permits, in accordance with:

ARTICLE 60.- Risk assessment is a process in which, on a case-by-case basis, based on scientifically and technically supported studies drafted by the interested parties, the possible risks or effects of the experimental release of GMOs into the environment may cause to the environment and biodiversity, as well as to the health of animal, plant and marine species.

The potential risks to human health shall be the subject of a risk assessment prior to granting authorization to the GMO in question in accordance with the provisions of this legislation.

ARTICLE 61.- The following guidelines must be observed in performing a study and assessment of the risks:

I. Assessments must be performed on a case-by-case basis, in a transparent manner and based on scientific principles and the precautionary principle, taking into consideration the opinions of experts;

II. They will be undertaken in the relevant fields of specialization;

III. A lack of scientific knowledge or consensus shall not necessarily be interpreted as an indicator of a determined level of risk, the absence of risk, or the existence of acceptable risk;

IV. They must, at a minimum, be based on the potential risks that the release of genetically unmodified host organisms or parental organisms would pose if released into an identical environment;

V. The receptor organism, the genetic modification, including the genetic construction and insertion method, and the environment into which the GMO will be released shall be taken into consideration; and

VI. The nature and degree of detail of the information the assessments contain may vary from case to case, depending on the GMO in question, its intended use and the probable receptor environment.

ARTICLE 62.- The basic stages that the risk study and assessment shall follow are the following:

I. Identification of the new characteristics associated with the GMO that may imply possible risks to biodiversity;

II. Assessment of the likelihood that these potential risks may actually occur, considering the level and type of exposure to the GMO;

III. Assessment of the consequences should the potential risks actually occur;

IV. Estimation of the possible global risk that the GMO represents, based on assessment of the probability that the potential risks and identified consequences might actually occur; and

V. A recommendation on whether the potential risks are acceptable or may be managed, including the proposal of strategies for managing these potential risks.

ARTICLE 63.- When there is uncertainty with regard to the level of potential risk that GMOs entail to biodiversity, the corresponding Ministries shall, during the administrative process for the permit for the GMO environmental release activity in question, request additional information on specific particulars of the risk study or shall adopt appropriate strategies for risk management or monitoring of the GMO in the receptor environment.

Where there exists the risk of serious or irreversible damage, or uncertainty regarding the level of possible risk that GMOs may entail to biodiversity or human health, this shall not serve as a justification for the corresponding Secretariat to delay the adoption of effective measures to prevent negative consequences to biodiversity or human health. In taking such action, the corresponding Secretariat shall take into account the existing scientific evidence that provides a rationale or criterion for establishing a particular measure or measures; the administrative procedures established in this law, and the trade standards deriving from international treaties and agreements to which Mexico is a signatory.

One issue that has sparked particularly heated debate in Mexico is related to the use of GMOs related to species for which the country is known as the center of origin or center of diversity. The LBGMO addresses this issue in the following articles:

ARTICLE 86.- The species for which Mexico is the center of origin or genetic diversity and the geographic areas in which they are located shall be determined through joint resolutions of SEMARNAT and SAGARPA, based on the information contained in their archives and databases, including information provided by, among others, the National Institute for Statistics, Geography and Informatics, the National Institute for Research on Forestry, Agriculture and Fishing, the National Institute of Ecology, the National Commission for Knowledge and Use of Biodiversity and the National Forestry Commission, as well as international agreements and treaties relating to these fields. SEMARNAT and SAGARPA shall determine, in the resolutions they issue, what measures are necessary for the protection of these species and geographic areas.

ARTICLE 87.- To determine the centers of origin and genetic diversity, the following criteria shall be taken into consideration:

I. Centers of genetic diversity must be considered as those regions that currently host populations of wild relatives of the GMO in question, including different breeds or varieties of the same species, which constitute a genetic reservoir for this species, and

II. In the case of crops, the geographic regions in which the organism in question was domesticated, provided these regions are also centers of genetic diversity.

ARTICLE 88.- In the centers of origin and genetic diversity of animal and plant species, the release of GMOs will only be allowed when these GMOs are different from native species and provided that their release will not cause a negative impact on human health or biodiversity.

Of course, the other main controversy regards labeling of biotech products, which is handled so that products do not require labeling when they meet the criterion of substantial equivalence with respect to their conventional counterparts. Thus, Mexico has made its regulation compatible with that of its main trading partners: the United States and Canada.

ARTICLE 101.- GMOs or products containing genetically modified organisms, authorized by the SSA on the grounds of their safety in the terms of this Act and intended for direct human consumption, must make explicit reference to genetically modified organisms on the label and provide information regarding their food contents and nutritional properties, in cases where these characteristics are significantly different from the respective conventional products, and in addition to labeling requirements must comply with the general requirements described in the Mexican official standards issued by the SSA, in accordance with the provisions of the General Health Law and its regulatory supplement, with the participation of the Secretariat of Economy.

The information indicated on the labels in accordance with the provisions of this article must be true, objective, clear, understandable, useful for the consumer and based on scientific and technical information.

The labeling of GMOs in the form of seeds or plant material for sowing, cultivation and agricultural production shall be subject to the Mexican official standards issued by SAGARPA with the participation of the Secretariat of Economy. With respect to this type GMO, it shall

be compulsory to indicate on the label that it is a genetically modified organism, as well as the characteristics of the acquired genetic combination and its implications relative to special crop conditions and culture requirements. The changes in reproductive and productive characteristics must also be included.

Evaluating compliance with these Mexican official standards shall be carried out by the SSA, SAGARPA and the Secretariat of Economy within the ambit of their respective competences, and by persons accredited and approved in accordance with the provisions of the Federal Law on Metrology and Normalization.

ARTICLE 102.- Requirements concerning the information to be contained in the documentation accompanying GMOs imported in accordance with this Act shall be specified in Mexican official standards derived from this legislation, considering in their issuance the final purpose these organisms will be given and the provisions of international treaties to which Mexico is a signatory. The Mexican official standards described in this article shall be jointly issued by SAGARPA, the SSA and the Secretariat of Economy. In cases where GMOs are imported for the purpose of release into the environment, the Mexican official standards described in this article shall be issued by the aforementioned Ministries in conjunction with SEMARNAT.

Access to biodiversity and genetic resources.

The issue of regulating access to so-called genetic resources, especially in so-called megadiverse countries, has become, since the ratification of the Convention on Biological Diversity (CBD), one of the most urgent items of the international agenda on biodiversity. There are a sufficient number of documented cases of illegal access to biological materials that ultimately led to the acquisition of intellectual property rights by persons or corporations that obtained the materials illegally. What's more, oftentimes the leads that let those searching for biological materials know what to look for or where come from the knowledge of indigenous communities of traditional villagers who are not allowed to share in the potential benefits obtained from the knowledge and biological materials. The CBD (Article 15) recognizes the sovereignty of national governments over the genetic resources present in their territory and their right to legislate on these issues. It also identifies the concepts of Prior Informed Consent (PIC) and Equitable Sharing of Benefits (ESB) derived from such access. Additionally, it establishes commitments regarding the transfer of biotechnology and respect for traditional knowledge. To a certain extent, the CBD simply challenges national governments to legislate with respect to their genetic resources.

Mexico has developed a framework for non-commercial scientific research. There are two paths to obtaining a permit (Articles 87 and 87b of the General Law on Ecological Balance and Environmental Protection; and Mexican Official Standard

(NOM) 126. NOMs are technical standards that provide a regulatory framework for legislation to be enforced). The most important aspect consists in transferring a certain measure of the government's responsibility for granting permits to Mexican researchers who are recognized and established. Thus, an investigator who has obtained a "Scientific Collector's License" can extend permits to her Mexican and foreign students and collaborators. This is accomplished with minimal bureaucracy (indeed, almost none) and merely requires annual reporting of where the materials are deposited and refraining from collecting endangered species (listed in NOM 059). Current legislation requires, besides obtaining a federal permit, obtaining the prior informed consent of the owners (private or communal) of land where the collection takes place. Thus, in Mexico, two prior informed consents are required: that of the federal government, and that of the landowners. Obtaining a government permit does not guarantee that private permission will be granted.[74]

There is still no legislation regulating access for commercial purposes.[75]

The Special Concurrent Program for Sustainable Rural Development.

On November 30, 2007, the Calderón administration presented the new Special Concurrent Program for Sustainable Rural Development 2007-2012 (PEC), which consolidated the number of programs from 136 to 15, with 36 subprograms, 82 support components and areas of special attention: Competitiveness, Social Issues, Finance, Infrastructure, Labor, Environment, Education, Health and Agriculture. The intention was to eliminate redundancies and promote the specialization of functions without excluding any sector support activities. It has already been mentioned that the complexity of bureaucratic structure is still very formidable and, despite this attempt at rationalization, the problem of redundancy and waste remains serious.

The restructuring involved the drafting of new Operating Rules, with an attempt to simplify them to ensure better access to the programs on the part of rural communities, greater transparency and consistency, in order to promote over the

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[74] Soberón, J. (2005), "Comentarios Sobre la Legislación de México en Relación con el Acceso a los Recursos Genéticos," *Biota Neotropica*, Vol. 5 (number 1): 2005

[75] Since 2006, there has been an initiative in Congress. According to the draft of the Federal Law on Access and Exploitation of Genetic Resources submitted by the Senate to the Chamber of Deputies, the proposed legislation would regulate access, use, exploitation, conservation and protection of genetic resources, as well as the fair and equitable distribution of the benefits derived from their commercialization.

following years a convergence of resources and better results in poverty reduction goals in rural areas.

The PEC was conceived as a tool for crosscutting integration of the policies and instruments of the federal government to promote all aspects of development in rural areas of Mexico. Its objectives are the following:

- Objective 1. Improve the average income of the lowest-income rural households in real terms.
- Objective 2. Improve food security for Mexican families.
- Objective 3. Increase the GDP of the food and agriculture sector.
- Objective 4. Increase productivity in agriculture, livestock and fisheries.
- Objective 5. Increase exports of food and agriculture products.
- Objective 6. Diversify the sources of income of rural producers.

The Policy on Science, Technology and Innovation for the Rural Sector.

This instrument designed for the administrative period 2006-2012 sought to combine the efforts of government agencies and promote the participation of public and private organizations in efforts to provide the agriculture, livestock and fisheries sector with science and technology options to sustain development that is profitable, competitive and sustainable in the long term, promote economic and social development and the conservation of natural resources. Its main axes and strategies include:

Axis I: Position innovation as a central element in government programs.

Strategy I.1.- More public and private sector resources for innovation.

Strategy I.2. Consolidate the generation and use of patents and products that promote the development of rural areas in comprehensive terms.

Strategy I.3. Development of providers of Research, Technology Transfer and Innovation services.

Strategy I.4. Diffusion of issues related to technological innovation in national media.

Axis II.- Establish a legal, regulatory and operational environment oriented toward results.

Strategy II.1.- Appropriate regulatory framework that encourages processes of technological innovation.

Strategy II.2. Greater precision and consistency in legislation on Science and Technology.

Strategy II.3. A program of monitoring and objective assessment that facilitates accountability.

Axis III.- Identify areas of national strategic interest in the short, medium and long term.

Strategy III.1. Curricula and study plans of research and higher education institutions focused on addressing domestic needs.

Strategy III.2. Effective planning and survey systems.

Strategy III.3. Human, economic resources and infrastructure focused on issues of local, regional and national import.

Axis IV. Consolidate institutional efforts and infrastructure to develop knowledge, solve problems and organize programs.

Strategy IV.1. Comprehensive programs in the short, medium and long term, linked to demand, to boost technological innovation.

Strategy IV.2. Knowledge management system

Strategy IV.3. Orientation and better utilization of critical masses in Science and Technology, for a closer alignment of the actors.

Strategy IV. 4. Leverage the comparative advantages of each instruction and their complementarity.

These policy axes are clearly relevant to the goal of generating innovations that lead to real improvements in the productive structure of the sector. The strategy planning seems adequate, but the results have been insufficient.

Main support programs in the food and agriculture sector.

SAGARPA programs[76]

Program to Support Investment in Equipment and Infrastructure, including the following components:

a) Agriculture, Livestock and Fisheries;

b) Protected Agriculture;

c) Electrification of Fish Farms;

d) Fisheries and Aquaculture Infrastructure;

e) Ecological Replacement of Marine Engines;

f) Post-Production Management (including TIF slaughterhouses, FIMAGO, PROVAR infrastructure and infrastructure for meat packing plants);

g) Modernization of the Fishing Fleet and Rationalization of Fishing Activities;

h) Genetic Resources (agriculture, livestock and aquaculture), and

i) Traditional Productive Assets.

PROCAMPO Live Better Program to Support Income from Agriculture and Fishing, including the following components:

a) PROCAMPO: Live Better;

b) Agricultural Diesel/Modernization of Agricultural Machinery;

c) Marine Diesel;

d) Development of Coffee Production; and

e) Shore Fishing Gasoline.

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[76] Resolution Making Known the Operating Rules of Programs of the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food, published in the Official Gazette on December 30, 2011, and amended July 23, 2012

Program for Risk Prevention and Management, including the following components:

a) Support for Target Income and Commercialization (includes contract farming and contract husbandry);

b) Response to Natural Disasters in the Agriculture, Livestock and Fisheries Sector;

c) Guarantees (includes guarantees for acquisition of fertilizers and fisheries development);

d) Fund for Stimulating Investment in Areas with Medium, High and Very High Underdevelopment Indices; and

e) Medical Services.

Program for Development of Rural Capacities, Technological Innovation and Infrastructure, including the following components:

a) Support for the Development of Projects (includes support to Social Organizations, Development and Management of Projects and Supply Chains);

b) Development of Rural Capacities and Infrastructure (includes Comprehensive Training to rural producers, women and young people); and

c) Innovation and Technology Transfer.

Program for Sustainability of Natural Resources, including the following components:

a) Bioenergy and Alternative Energy;

b) Conservation and Sustainable Soil and Water Use (COUSSA);

c) Reduction of Fishing Activities;

d) Fisheries Inspection and Surveillance;

e) Fisheries and Aquaculture Management;

f) Sustainable Fish Production and Livestock and Apiculture Management (PROGAN); and

g) Crop Conversion.

Program for Joint Action with States to Promote Investment, Sustainability

and Capacity Development

Strategic Projects, including:

a) Strategic Project for Food Security (PESA);

b) Development of Arid Zones (PRODEZA);

c) Humid Tropics;

d) Support for the Supply Chain of Maize and Bean Producers (PROMAF) (includes production, high-yielding varieties and seeds of beans and maize native to Mexico and intended for domestic consumption).

Program for the Acquisition of Productive Assets (Alliance for the Countryside)

The Program for the Acquisition of Productive Assets was created to help increase the strategic capital goods of rural and fishing communities by subsidizing investment in rural areas and economic activities in the areas of primary production, health and safety, added value processes and access to markets, as well as the productive activities of the rural sector as a whole. The Alliance has undergone repeated transformations, both in its design and its approach. Today, it is geared toward impacting the production and productivity of rural production units, their capitalization, technological innovation and training, with the goal of improving the incomes of rural producers. The design and operation of the Alliance is conceived within the four strategic policy axes, which include agriculture and fishing production chains, crop conversion, attention to critical factors and to priority regions and communities.

Its aim is to increase capitalization of the economic units of rural farmers and fishermen by subsidizing investment in strategic capital goods in the areas of primary production, health and safety, added value processes and access to markets, as well as the productive activities of the rural sector as a whole.

Assistance categories: 1. Equipment and machinery. For primary production processes (tractors, cultivators, plows, harrows), harvesting (combines for sorghum, maize, sugarcane, etc.), capture, conservation, ocean safety, post-harvest handling

(packaging machinery), processing of primary production and non-agricultural production and services. 2. Plant material, husbandry and aquiculture species. Livestock production (breeding stock, sires, queen bees, birds) and aquiculture such as juveniles or hatchlings, and plant material for perennial plantings (avocado, citrus, peach, cuttings of rose, blackberry, etc.). 3. Infrastructure. Construction, renovation or expansion of types of buildings and facilities (shade, feeding and watering facilities for cattle, cold rooms, etc.) including marine vessels, that figure as part of a production or regional development initiative.

Program for Attention to Structural Problems (Compensatory Assistance)

This program was created with the goal of increasing operating margins by delivering resources to offset the expenses of farmers and fishermen relative to their incomes, framed in a series of subprograms with differing and specific purposes. Assistance categories:

- Direct Assistance in the Form of Price Hedging for Eligible Products and Species
- Target Income
- Coordination Agreements
- Market Planning for Grains and Oilseeds
- Specific Marketing Programs

Program for Developing and Promoting Rural Finance Models

This program is intended to strengthen credit institutions in rural areas, providing access to financial services to communities having medium, high and very high underdevelopment indices. Assistance categories:

A1. Strengthening of financial intermediaries.- Refers to services including developing assessments, business plans and implementation thereof; primarily in areas of accounting, finance, cash flow management, lending, risk analysis, branch operations and legal advice in the constitution of financial instruments. Also includes assistance for automation in the categories of acquisition of IT equipment, computer systems and network communication tools, equipment for accessing the internet and contracting databases related to its operation, introduction of new products and implementation of security mechanisms, that allow them to comply with the guidelines of regulation developed by the National Banking and Securities Commission

(CNBV) or the Technical Agent of the component.

A2. Strengthening of financial intermediaries.- Resource contributions to financial institutions that expand their lines of credit or commit to opening new branches in areas underserved by financial services. These resources shall be invested under terms and conditions to be described in the business plan submitted by the applicant.

B. Capitalization of financial intermediaries.- Refers to direct, one-time contributions to establish liquid reserves, without withdrawal rights, in the capital stock of financial institutions that are newly-formed or seeking permission to operate.

C. Monitoring, supervision, self-regulation and rating of financial intermediaries and integration organizations.- Resources are intended to support the processes of authorization by the CNBV and self-regulation where appropriate, for monitoring of financial performance, group access to technology and information systems, publication of indicators, contracting rating agencies to evaluate financial intermediaries and integration organizations.

Strategic Protected Agriculture Program (PROAP)

Encourage the development of protected agriculture by providing shared risk assistance to applications for investment in clusters that bring together producers with different production capabilities by region and technological level and facilitate their development with criteria of competitiveness and sustainability, that promote the integration of producers through specialized consulting and technical and market support, promote job creation, income growth and the improvement of living standards.

In conjunction with the resources distributed under PROAP, both for projects to increase production capacity and new projects, assistance shall be granted for investments in infrastructure and equipment for production under the system of protected agriculture, in the following types of technology:

- Macro tunnel
- Shade house or mesh
- Greenhouses with technology appropriate to the conditions of each region and crop.

Special Program to Assist the Production of High Performance Maize and/or Beans (PROEMAR)

This program aims to integrate various initiatives under a single criterion (value added). It provides assistance to agribusiness chains, primarily those embedded in agriculture, livestock and aquaculture production chains; it also focuses on directing actions and assistance provided under PROVAR to producer organizations in the rural food industry.

Train specialists in high-yield agriculture, agricultural diagnostics, creation of production initiatives and comprehensive technical assistance services, for the purpose of disseminating this technology among the producers of maize and beans to achieve higher crop yields and cost reduction per ton produced, to increase profitability and productivity.

For first-year applications, the program will provide additional support in the form of the Technical Support component, which in turn will be composed of the following categories:

- Training for technicians responsible for operational activities through high-productivity courses in maize and/or beans
- Technology workshops directed to producers
- Diagnostics based on soil analysis.
- Specialized consulting and field monitoring to technicians and producers provided by specialized technical offices.
- Specialized technical assistance provided by technicians hired by producer organizations.

For second-year producers, the program will provide additional support in the form of the Technical Monitoring component, which in turn will be composed of the following categories:

- Second cycle of technician training, including at a minimum: evaluation of previous year's results, identification of management practices with the greatest impact on production in each region, response to different inputs applied in the previous cycle, system of monitoring for the current year, agricultural diagnostics and generation of progress reports.
- Specialized consulting and field monitoring to technicians and producers provided by specialized technical offices.

Project of Value Added Assistance to Agribusiness Enterprises with Shared Risk Programs (PROVAR)

Apply shared risk programs for assisting agribusiness enterprises with a business model and market vision incorporating value added to primary production, coordinating strategic initiatives of SAGARPA and linking to actions and

technologies of environmental conservation through the provision of additional financial services, promoting the use of renewable energy.

Assistance categories:
- Food Industry Projects
- Tourism in Rural Areas
- Biogas
- Organic Certification

Program for Sustainable Livestock Production and Livestock and Apiculture Management (new PROGAN)

The Program for Sustainable Livestock Production and Livestock and Apiculture Management or new PROGAN is the continuation of the Incentives for Livestock Productivity Program. The new PROGAN includes a new strategy for boosting productivity and encouraging technology adoption, as well as supporting conservation and improvement of natural resources and livestock areas.

The new PROGAN expands its coverage to include cattle production for meat and dual purpose grazing, bovine milk production in family production systems, sheep and goat husbandry and beekeeping.

Furthermore, with the aim of a more equitable distribution of assistance, different types of assistance will be given to producers at different scales.

Risk Sharing through FIRCO[77]

The assistance provided under programs operated by FIRCO is based on the concept of risk-sharing, a government policy instrument used to contribute to the comprehensive development of the rural sector by channeling additional financial resources to help minimize risks associated with investments in strengthening production chains and economic diversification. These resources are recoverable without financial cost or profit sharing in the form of investment that will be repaid

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[77] The Shared Risk Trust **(FIRCO)** is a state-owned entity established by presidential decree and working in collaboration with the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) to promote agribusiness, rural development at the local level, and act as a technical agent in initiatives directed at the agriculture and fisheries sector.

upon the success of its objectives. In the case of resources classified as subsidies, their repayment will benefit the producers themselves.

Risk-sharing is a development tool that allows for channeling of public, private or mixed resources to increase the financial leverage of investors and overcome initial obstacles to acquiring the venture capital or credit required for the success of their initiatives. Programs include:

- Protected Agriculture Program.
- Bioeconomy Program.
- Bioenergy and Alternative Fuels Program.
- Program for Meat Packing Plants.
- Sustainable Productive Diversification Program.
- FIMAGO Program (capitalization of companies producing grains and oilseeds)
- PROMAF Program (technical assistance, training and technological innovation for producers of maize and beans).
- Provar Program (improvement of post-production processes).
- Aquatic Subsystem Genetic Resources Program.
- T.I.F. Slaughterhouses Program.
- Irrigation Modernization Program.
- Humid Tropics Program.

Quality certification.

The Systems for Reducing Risks of Contamination administered by SENASICA (National Service of Health, Food Safety and Food Quality) are the measures and procedures established by SAGARPA in the Mexican official standards and other applicable regulations to ensure that produce achieves optimal sanitary conditions by reducing physical, chemical and microbiological contamination through the application of Good Agricultural Practices (Federal Law on Plant Health).

Businesses and producers dedicated to primary production of agricultural products in their stages of production, harvest and/or packing that comply with the measures and procedures established receive a certificate of implementation of Systems for Reducing Risks of Contamination issued by SENASICA.

Producers must follow the following steps to participate in this **voluntary program**:

1. Officially register the agricultural enterprise on SENASICA's website and report that you have begun implementing the Systems for Reducing Risks of Contamination in primary production of agricultural products in the production units or areas and print out the registration numbers assigned to the company and the field, harvest and/or packing section(s).

2. Appoint an employee responsible for Systems for Reducing Risks of Contamination, who will be in charge of implementing and monitoring activities related to the system in primary production of foods of agricultural origin.

3. Implement a program for Reducing Risks of Contamination in the field, harvest and/or packing section(s), in accordance with the requirements for implementing the Systems for Reducing Risks of Contamination in primary production of foods of agricultural origin.

México Calidad Suprema.

México Calidad Suprema is a nonprofit made up of producers, packers and their organizations, with the aim of working with the federal government to promote the development and strengthen the competitiveness of rural areas of Mexico through outreach, training, consulting, coordinating certification and promoting the "México Calidad Suprema" brand domestically and abroad.

Collective marks and appellations of origin.

Recently, the use of industrial property mechanisms to promote the differentiation of food products covered by collective marks or appellations of origin has been gaining ground.

The example of the "Tequila" appellation has inspired various groups of imitators. A recent example is the case of the habanero chili, whose producers have begun to venture this product onto the international market bearing an appellation of origin. The model has worked well in this case, strengthening the producer organization and bringing other farmers to understand that the appellation must be accompanied by technical capabilities to meet safety requirements. Yucatan has been promoting a

comprehensive project between input suppliers, researchers, producers and authorities that has allowed the product to gain market value and position.[78]

CONACYT Programs.

CONACYT manages various programs to support projects in science, technology and innovation. These include the **Incentives for Innovation Program (PEI)**, a program that provides direct assistance in the form of a partial subsidy to cover the costs of projects directed at Mexican companies listed on the National Registry of Institutions and Companies in Science and Technology (RENIECYT) that perform RTDI activities in Mexico, either independently or in association with other companies or higher education institutions (HEIs) and/or research centers and institutes (RCs), in Mexico or abroad. The program includes assistance in three categories:

INNOVAPYME: Reserved exclusively for proposals and projects submitted by micro, small and medium-sized enterprises (MSMEs). These companies may submit proposals either independently or in association with higher education institutions (HEIs) and/or research centers and institutes (RCs).

INNOVATEC: Reserved exclusively for proposals and projects submitted by large companies. These companies may submit proposals either independently or in association with HEIs and/or RCs.

PROINNOVA: Reserved exclusively for proposals and projects submitted in association with at least two HEIs and/or RCs.

Strategic Alliances and Innovation Networks for Competitiveness

This program aims to encourage the creation of strategic alliances and innovation networks (Spanish acronym AERIs) to help raise the competitiveness of productive sectors in Mexico, as well as research, technological development and innovation (RTDI) projects submitted by duly formed AERIs. The formation of AERIs is intended to achieve:

[78] Presentation by Juan Carlos Deón at a roundtable discussion with producers and researchers hosted by SINAREFI, Cuautitlán, Mexico, September 8, 2012

1. Building and retention of capacities in the medium and long term, with the goal of self-sustainability.

2. Training human resources according to production demand and their involvement in production processes, incorporating the involvement of professionals with master's or doctoral degrees.

3. Direct partnerships between the productive sector, research centers and institutions of higher education.

4. Generate focus areas of technological innovation that will be developed or strengthened by the formation of AERIs.

The Institutional Fund for Regional Development through the Promotion of Science, Technology and Innovation (FORDECyT).

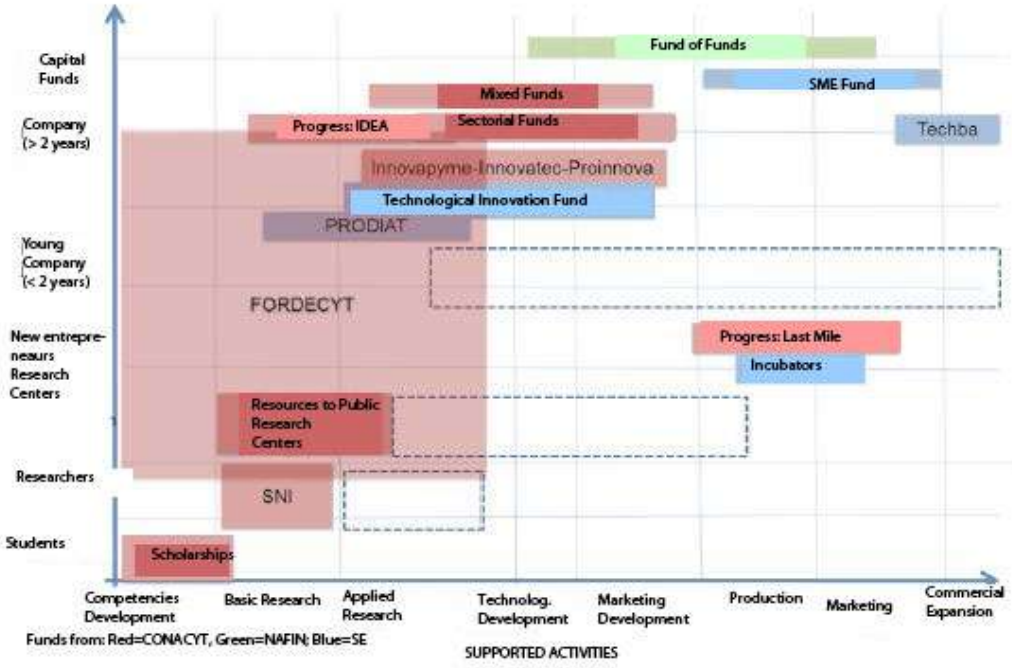
The Fund is a CONACYT program seeking to assist in the economic and social development of various regions of the country by financing research, development and technological innovation proposals with high impact potential that generate opportunities for improvement. Its aim is to encourage scientific, technological and innovation activities as well as the training of high-level human resources to contribute to regional development, collaboration and integration of the various regions of the country and strengthening regional science, technology and innovation systems.

Figure 2 shows the map of financial support for innovation in Mexico. As we can see, this is a very comprehensive program that accompanies the entire lifecycle of investment in innovation.

The problem is the availability of resources to fund programs. Taking the PEI for example, which had a budget of 2 billion pesos in 2012 (approximately US$160 million), it faced demands on its resources by companies to the amount of more than 30 billion pesos, which resulted in very high rate of rejection for projects.[79] In fact, only one in ten projects submitted actually received support, resulting in negative effects on companies that do not receive support. **The problem of resources for innovation is serious and structural.**

Figure 2. Programs for financing innovation in Mexico.

[79] Presentation by Miguel Chávez at the National Conference on Science and Technology, Monterrey, N.L., October 2012



Source: Secretariat of Economy (2011), National Program for Innovation, Mexico City.

Programs of the Secretariat of Economy.

Through FOCIR,[80] a federal program was launched in 2004 under the administration of the Secretariat of Economy, offering financial aid in the form of repayable assistance and targeted at micro, small and medium-sized enterprises. Its programs include:

- The **SME Productive Projects Program**, which promotes national economic development by granting assistance to projects that promote the development, consolidation and productivity of MSMEs and the creation of more and better jobs
- The **Seed Capital Program**, which provides temporary financial assistance for startup and early-stage business development to entrepreneurial projects that are incubated by one of the business incubators belonging to the national system of business incubators of the Secretariat of Economy.

[80] Fund operated by the Secretariat of Economy with the mission, "To support investment flows toward rural development and agribusiness by promoting investment banking services oriented to the financing and capitalization of companies that have proven successful or have high potential for growth."

- The **National Franchise Program** is a program that makes it possible to start a new business with the support and experience of a franchising company, increasing its chances of success and supporting the permanent creation of new jobs.

The Secretariat of Economy also manages a program to refund import duties to exporters (Drawback). Its aim is to benefit exporters by granting a refund of the general tax on imports (in the case of the agriculture sector, seeds) paid on goods that are incorporated into goods that are subsequently exported (i.e., processed and non-processed agricultural products), or on the importation of goods that are returned in the same state or have been subjected to processing or alteration.[81]

Another program to which agribusiness companies can apply for the type of inputs required for the processing of their products is the IMMEX (Manufacturing, Maquiladora and Export Services Industry) Program. This is a tool whose purpose is to simplify the procedures and requirements, and incorporate services into the maquila system. Through this program, businesses can temporarily import goods needed for use in industrial processes or services whose ultimate purpose is the production, processing or repair of goods imported for a specified period of time and subsequently returned to the external market. Additionally, there is a program of financing available through the sector-based programs known as PROSEC. This tool in directed towards companies that produce specific goods, allowing them to import under a "preferential ad-valorem tariff" goods meant for the manufacture of other products, regardless of whether such products are intended for the domestic market or export.

The agribusiness sector includes some companies with a high level of technological development. These companies can apply for the Program for Development of High Technology Industries (PRODIAT), which aims to contribute to the promotion of transfer and adoption of advanced technologies to boost competitiveness in the pioneering innovation and high-tech sectors.

As has been noted, the aforementioned funds are primarily directed at medium and large companies. However, small and micro-enterprises can apply for funding through the program known as the Fund for Assistance to Micro, Small and Medium Enterprises (MSMEs). Its purpose is to provide assistance to MSMEs by delivering

[81] PROMÉXICO. (2011). *Catálogo de financiamiento y programas federales de apoyo.* Mexico City.: Secretariat of Economy, Mexico

assistance to projects that contribute to economic development and investment by companies and entrepreneurs. The beneficiaries of this program are basically entrepreneurs, micro, small and medium enterprises, but family-owned workshops may also qualify by registering with the Secretariat of Economy (Spanish acronym SE).

Because commercial banks are not involved in financing innovative companies, whether in manufacturing or in agribusiness, these companies can obtain funding through the development bank known as the National Bank for Foreign Trade (BANCOMEXT), which has a working capital fund to assist the financial needs of businesses that carry out productive activities associated primarily with export. This assistance is channeled into the production, purchase of domestic or imported raw materials, storage or inventory maintenance, direct export sales, or the construction and furnishing of warehouses and industrial buildings for sale or rent. Its beneficiaries are export companies and their suppliers.

National Program for Innovation.

On June 12, 2009, a Decree was published in the Official Gazette which amended various provisions of the Law on Science and Technology. The changes included new wording that described innovation as an element of the highest importance for establishing linkages and increasing the productivity and competitiveness of the production and service sectors. Furthermore, it also provides for the creation of the **Intersectorial Committee for Innovation** (CII) (Art. 41 LCyT). The CII is the specialized instance of the General Council on Scientific Research, Technological Development and Innovation that is responsible for designing and coordinating the operation of public policy on innovation. Among its faculties is the power to approve the National Program for Innovation and report its results to the General Council (Art. 41b LCyT).

Thus, in 2011 the National Program for Innovation was established with the goal "to enact public policies that promote and strengthen innovation in the production and service sectors to increase the competitiveness of the national economy in the short, medium and long term."

The Program is based on the following fundamental principles:

1. Innovation is a national priority because only through it can we increase the competitiveness of our economy and achieve the growth rates and creation of quality jobs that Mexico requires.

2. Because of the shortage of available resources, efforts must be focused on the areas of greatest impact.

3. To develop a comprehensive strategy, it is necessary to establish mechanisms of coordination among different agents.

4. Accountability mechanisms will allow for continual revision and improvement of public policy.

The Program's specific goals are:

Objective 1: Strengthen internal and external demand for innovative businesses, business models, products and services created in Mexico.

Objective 2: Increase the availability and applicability of knowledge directed at innovation.

Objective 3: Strengthen the base of companies and public agencies that demand the generation of innovative ideas and solutions for the market.

Objective 4: Promote the synergy of public and private resources to diversify the funding sources necessary to entrepreneurship and innovation.

Objective 5: Improve and increase the productive, creative and innovative contributions of individuals.

Objective 6: Pave the way for a regulatory and institutional framework that favors innovation.

The National Program for Innovation certainly has an appropriate focus on the competitiveness of strategic sectors. It is noteworthy that only one branch of the agricultural sector is covered, while the food processing sector is deemed highly competitive and therefore likely attract investment (See Figure 3), which confirms the secondary position of agriculture in the economic priorities of the Mexican government.[82]

Despite this strategic orientation and the number of focus areas proposed by the Program, questions have emerged as to its timeliness. We are on the threshold of the transfer of power to a new federal administration, which presents a high probability of changes and adjustments in policy.

[82] During this administration, SAGARPA was considered part of the social cabinet but not the economic cabinet.

Additionally, as discussed earlier in this study, there remains a scarcity of resources to provide to programs and projects associated with the fulfillment of its objectives. In fact, the program identifies only as "next steps" the establishment of a system of indicators managed by a Specialized Committee on Statistics in Science, Technology and Innovation

Figure 3. National Program for Innovation.

Fuente: The Boston Consulting Group, 2009

Translation: Strategic Sectors.

Environmental Sustainability Clean Technologies	1 High Impact and competence sectors (Attract investment and industry development)	2. Internal Market Development (Continue promoting sound development)	3. Development of Professionals and Entrepreneurs (Promotion to foster new companies)
	1. Transportation equipment manufacturing 2. Machinery and Equipment manufacturing 3. Electronic and electric equipment manufacturing	1. Commerce 2. Dwelling **3.** Financial Services	1. Fruit, flowers and vegetables agriculture 2. Software and physical means 3. Research and Development Services (R&D) 4. Architecture,

Environmental Sustainability Clean Technologies	1 High Impact and competence sectors (Attract investment and industry development)	2. Internal Market Development (Continue promoting sound development)	3. Development of Professionals and Entrepreneurs (Promotion to foster new companies)
	4. Mining (including gas and petroleum) 5. Business support services 6. Food Industry 7. Health Services **8.** Tourism		engineering, design services **5.** Music, films, radio and TV
	4. DEVELOPMENT PLATFORMS Ensure platform development through suitable regulations, more investment, and more competition		
	1. Infrastructure	2. Telecommunications	3. Educational Services

Sectorial Innovation Fund (FINNOVA).

In accordance with the Law on Science and Technology, the objectives of the Sectorial Innovation Fund (FINNOVA) are the promotion of scientific research, technological development and innovation; the national and international registration of intellectual property; the training of specialized human resources; scholarships; creation and strengthening of research groups, academic bodies and professionals engaged in research, technological development and innovation; diffusion of science, technology and innovation; the infrastructure required by this sector; the creation and development of networks and/or regional partnerships for technology and innovation, tech-based companies and activities, knowledge transfer partnership units, technological networks and/or alliances, strategic partnerships, consortia, business clusters or new innovative companies; liaising between sources of science, technology and innovation and the production and service sectors; the creation of companies and nonprofits whose purpose is the creation of science and technology networks and liaising between sources of science, technology and innovation and the production and service sectors; the development of innovation initiatives for regional development in areas identified and defined as priorities by the regional innovation networks and/or alliances; the formation of systems of technology management in companies; the creation of seed and venture capital funds for the formation of companies based on knowledge; the creation and consolidation of science and technology parks; the creation of venture capital instruments for innovation, and other tools described in the Law on Science and Technology for the promotion and development of innovation to strengthen the

research and development capacities of the economic sector, and funding the operating and administrative expenses necessary to the Fund's successful operation.

FINNOVA has offered assistance in the following categories:

- Mitigation of greenhouse gases.
- Productive biotechnology.
- Strengthening the innovation ecosystem.
- Knowledge transfer offices.

Fund for Technological Innovation (FIT).

A public trust created by the Secretariat of Economy, Office of the Deputy Minister for Small and Medium Enterprise and the National Council for Science and Technology (CONACYT), with the purpose of assisting micro, small and medium-sized enterprises, as well as individual entrepreneurs, with the development or adoption of innovation and technological development. The Fund aims to support projects that generate innovation, technological development, jobs and competitive advantages for Mexican MSMEs. The following are its categories of assistance:

1. New and/or improved products, processes, services or materials containing innovation.
2. Creation and consolidation of engineering, design, research and technological development facilities.
3. Creation of new businesses with high added value, able to generate a competitive advantage.

The priority sectors identified by the FIT are:

1. Advanced manufacturing systems
2. Health technologies
3. Food and agriculture
4. Biotechnology
5. Nanotechnology
6. Mobile and multimedia technology
7. Cleantech and renewable energy

Summary of the main policies and legal frameworks.

Table 1 summarizes, in accordance with the Methodological Guidelines, the components of the institutional framework relating to innovation in the food

industry. It may be observed that Mexico has a very comprehensive legal framework, underpinned by the Laws on Sustainable Rural Development and Science and Technology.

Together, both laws encompass virtually all aspects related to the value chain of knowledge, from research to the commercialization of innovative products.

This framework also includes modern legal instruments for the protection of intellectual property, covering inventions, industrial designs, appellations of origin, collective marks, plant breeder's rights and copyrights. There is also a judicial framework for prosecuting piracy and counterfeiting.

The biosafety legislation is complete and strict, regulating all acts related to the use of genetically modified organisms, including marketing of GMO-derived and GMO-containing food products.

Access to biodiversity resources is regulated for research, but there is a legal vacuum regarding access to these resources for commercial purposes.

The quality and safety aspects of agricultural inputs and food products are regulated by various pieces of legislation, including the plant and animal health law and seed certification and trade law, while food safety issues are addressed through the General Health Law.

Income distribution has been a priority issue since the signing of the North American Free Trade Agreement, which sought compensatory measures. The Federal Law on Sustainable Rural Development provides the basis for maintaining PROCAMPO and other programs of assistance to producers, as well as mechanisms for providing training, technical assistance and access to finance.

That law also addresses issues related to the marketing of food products, as does foreign trade legislation as well as specific programs that provide assistance in the form of information, financing and consulting.

The Law on Science and Technology establishes the basis for orienting research primarily toward solving problems and strengthening the competitiveness of the productive sector and defines incentives programs for promoting linkages and technology transfer.

It includes specific policies for developing the food industry (the PEC) and a science, technology and innovation policy for the rural sector.

The diversity of assistance programs is very broad and we can say that it has a wide compass in terms of subjects of assistance, types and conditions of financing, technical assistance and training. However, the existence of so many programs presents a huge coordinating challenge that has yet to be overcome.

Despite this assortment of regulatory instruments and incentives, the results have been insufficient, mainly for the following reasons:

Lack of resources to implement activities proposed under the programs, which results in failure to meet their objectives.

Dispersion and duplication of programs, causing confusion for users, redundant allocation of resources to meet similar objectives and neglect of certain regions and classes of producers. This dispersion prevents a comprehensive focus on the various factors that make up a value chain. Consequently, incentives are offered in a fragmentary way that diminishes their efficacy.

Institutional timeframes poorly coincide with those of producers, due to the bureaucratic complexity involved in issuing calls for proposals and terms of reference, as well as poor fiscal accountability causing most programs to operate on a year-to-year basis.

According to the interviews conducted as part of this study, there is a lack of vision in either the design or operation of these programs. It is relatively common for decision-making to be influenced by political considerations and the arbitrary selection of beneficiaries of assistance. This creates distrust among producers.

Table 1. Mexico: Components of the institutional framework for innovation in the food industry.

INSTITUTIONAL INDICATORS	Major legal frameworks		Major current policies	
	Main legal framework	Direct implications for the SNIA	Specific policies	Direct implications for the SNIA

The acquisition of technology by producers (innovation through modernization)	The Law on Sustainable Rural Development (LDRS) created the SNITT, whose function is to coordinate efforts toward development and technology transfer. There are direct funding sources for this purpose.	There are mechanisms of consultation with producers to establish innovation agendas. The producers benefit from innovation by acquiring specialized equipment and supplies.	Science, Technology and Innovation Policy for the Rural Sector. Development of Rural Capacities, Technological Innovation and Infrastructure, including the following components: a) Support for the development of projects; b) Development of rural capacities and infrastructure (includes comprehensive training to rural producers, women and young people), and c) Innovation and Technology Transfer.	Establishes mechanisms of coordination between organizations to promote technology transfer. Generates a resource base for technology projects, including training. Despite the policy framework, lack of institutional coordination remains a problem, with various institutions offering the same services to the same beneficiaries, while others are left without access. Lack of quality standards, programs are not assessed based on indicators that correspond to the characteristics of the rural sector, and are mainly based on metrics of activities rather than impact.
Acquisition of specialized equipment and inputs	LDRS (Art. 7): To promote sustainable rural development, the federal government shall promote the capitalization of the sector by	Very important as a basis for programs to support producers, with abundant resources.	Program for the Acquisition of Productive Assets (Alliance for the Countryside) System of Guarantees and	Offers assistance for purchase of equipment, genetic material (seeds, broodstock, embryos, etc.) and agricultural and fishing

	improving basic and productive infrastructure and providing production services and through direct aid to producers, enabling them to make necessary investments to increase the efficiency of their production units, improve their incomes and strengthen their competitiveness.		Early Access to Future Payments of PROCAMPO (PROCAMPO Capitaliza). Program to Support Investment in Equipment and Infrastructure.	infrastructure. These programs operate unevenly, mainly benefiting producers in commercial agriculture regions
Sustaining the income of agricultural producers (subsidies of some sort)	LDRS	Very relevant. Establishes a framework for assisting rural development, which results in programs and subsidies.	Program for Developing and Promoting Rural Finance Models. PROCAMPO Live Better Program to Support Income from Agriculture and Fishing	Very relevant. Channels resources in the form of direct and indirect subsidies (fuel, electricity, target prices, etc.) Not closely linked to productivity, improvements or innovation
Infrastructure and logistics			Strategic Program for Food Security (PESA) National Network of Agrotech Observatories and Strategic Database Development to support decision-making	Have little practical relevance for innovation. PESA focuses on highly marginalized producers and the National Network is a recent project.

			in the agricultural sector	
Marketing/ distribution	LFDRS	Relevant, but based on a complex bureaucracy	Basic Program for Production and Marketing of Products Offered by Rural Development Actors National System of Information for Sustainable Rural Development System of Information on Agricultural Foreign Trade Bulletin of agriculture and livestock prices Managing business opportunities Target income and marketing assistance PROMEXICO (refund of import duties to exporters)	Very relevant, but impacts mainly commercial producers
Investments in research and development	Law on Science and Technology	Very relevant. Establishes sector-based, mixed and cooperative funds, the main	Incentives for Innovation Program: Proinnova, Innovatec e Innovapyme	Very relevant, since they constitute the main source of R&D resources. Majority of resources are not

		sources of research funding. Creates a framework for prioritizing applied research Establishes the framework for creating Knowledge Transfer and Partnership Units in universities and public research centers. Creates the possibility of offering financial incentives to researchers who develop technologies that are transferred to industry.	SAGARPA-CONACYT Sector Fund for Agriculture Fund for Technological Innovation FINNOVA PRODUCE Foundations	intended specifically for agrifood projects. The resources of the Sector Fund and those administered by PRODUCE Foundations are specific and respond to the sector's agenda. The main limitation is insufficient budget. The lack of long-term planning due to annual budget cycles is an obstacle to strategic research
Public organizations	Law on Science and Technology	Very relevant	CONACYT Funds	Main source of funding for research projects at higher education institutions and public research centers
Private organizations		Does not exist	PEI Finnova	
Public-private networks and			Program for Strategic Alliances and Innovation	Exists but has no practical relevance for this sector

partnerships			Networks	
Protection of intellectual property and technology transfer	Law on Industrial Property Federal Copyright Law Federal Law on Plant Varieties	Relevant Is a protection system compatible with international standards. By protecting mainly foreigners, erects barriers to entry for domestic producers and companies	Intellectual property training	Exists, but has little relevance for the sector, because the courses are general in scope
Access and use of biodiversity resources	General Law on Ecological Balance and Environmental Protection	Exists but has little relevance, because standards have only been applied for research projects without commercial intent	SINAREFI	Exists and is relevant to identify, conserve and exploit plant genetic resources for food and agriculture. Networks of collaboration produced between producers and researchers.
Certification of quality and product differentiation (quality or environmental partnership labels)	Law on Organic Products Federal Law for Seed Production, Certification and Trade Federal Law on Metrology and Standardization	Very relevant for ensuring quality of inputs and products for specific niches	Good practices programs promoted by SENASICA. México Calidad Suprema	Very relevant to providing orientation and training. Create a certification system for producers.
Management training for producers and	LDRS	Is very relevant because it elaborates a	SINACATRI Development of	Relevant, although it has limitations w/r/t coverage and

workers		comprehensive training program.	Rural Capacities, Technological Innovation and Infrastructure	performance indicators
Training in technology management			FINNOVA: Knowledge Transfer Offices	Little relevance for the sector
Regional integration for innovation		Does not exist	Fund for International Cooperation in Science and Technology (FONCICYT) Bilateral programs	Little relevance for the sector, since it involves collaborations headed by innovative companies.
Environmental and Food Biosafety	Law on Biosafety of Genetically Modified Organisms Article 420 of the Federal Criminal Code	Very relevant. Establishes a strict assessment framework for research, use, importation and release into the environment of GMOs Defines the environmental crime of biosafety	CIBIOGEM-CONACYT Fund	Little practical relevance. Refers to research into biosafety, with emphasis on maize.
Bioremediation and waste recycling		Does not exist	FINNOVA: clean technologies	Little practical relevance. A recent program without specificity for the sector.
Regional integration for innovative	Law on Science and Technology	Relevant for coordination between state	FORDECYT	Exists but has little relevance to the

projects		councils	National Conference on Science, Technology and Innovation	sector. Relevant to coordinating statewide efforts.
Other	Federal Law on Sustainable Fishing and Aquaculture LFDRS	Relevant to fishing and aquaculture	National System of Information for Sustainable Rural Development	A very complete mechanism with relevant statistics on the sector

Source: Authors.

Integrative Analytical Framework (IAF).

According to the Guidelines, the IAF is a representative proposal for analytical integration and synthesis of the diagnostic information provided by the SNIAs. The idea is to arrive at a set of suggestions for broadening the capacity to innovate to create and appropriate value.

Categories of producers and products	Knowledge base, technologies and production systems	Actors / networks	Institutions	
Producers embedded in innovation systems	These producers have privileged access to technological resources from various sources (foreign and domestic), besides enjoying financial support and technical assistance (from professional service providers, research centers and enterprises)	Producers of commercial agriculture commodities Large and medium food processing companies. Producer associations organized with lobbying capacity to reach high echelons of politics. Producers of specialized products for sophisticated markets (organic, certified products, export-oriented food industry). Suppliers of equipment, inputs and services Research centers	Programs to support business innovation. Mixed and sector-based funds. Intellectual property system. Safety and biosafety regulations. Assistance to temporary import and export	Producers who participate actively in the SNIA are those who have integrated into global supply chains, with strong links to supply and consumer markets. Business success gives access to various sources of technology, both in Mexico and abroad, and they favorably utilize the institutional framework, government support and technical assistance tools.
Producers partially embedded in innovation	The producers in this segment have low competitiveness in commodities and therefore engage in	Farmers in transition Agribusiness SMEs that serve the domestic market.	SINACATRI SME Fund FIT	These are the producers that supply the domestic market with cost advantages and

systems	supplying local markets. Their technological resources are mainly internal, with some technical assistance components and sporadic contact with technology centers. They receive government support in equal measure to their resource management capacity.	Producer associations and some trade groups. Research centers Suppliers of inputs and machinery PSPs	FINNOVA Alliance for the Countryside SAGARPA Funds	proximity to local consumers. They receive support from public funding sources and to gain access to technical specialists, establish partnerships with technology centers and PSPs.
Excluded producers	Producers classified as excluded engage in subsistence production, with little commercial activity. Their technology resources are meager and of their own making. These include traditional technologies based on wood, for which the intellectual property system is marginal.	Subsistence farmers Microprocessors Charitable NGOs Higher learning institutions and technical schools	Procampo SINACATRI Program for Development of Rural Capacities, Technological Innovation and Infrastructure FONAES SME Fund	These producers face market disadvantages and their chances of survival are linked to their flexibility to switch products and reach low-income consumers. Their possibilities of innovation re lined to gradual changes in processes, especially to meet regulatory requirements for food safety.
	The diffusion of knowledge in the SNIA is heterogeneous and unequal in terms of access to knowledge on the part of different strata of producers and companies. There is also an uneven distribution regionally, since	The greatest diversity of actors participating in the articulation of a system is seen at the level of commercial production, both of commodities and of specialized products of the countryside and processed foods. As the economic capacity of producers is reduced, there is less	The existing institutional framework seeks to provide access to the benefits of the SNIA to all types of producers. In practice, institutions differ to meet fundamentally different demands, following the logic of the size,	The SNIA requires changes to gradually be able to act on reducing disparities in access to the benefits of innovation on the part of various actors and regions. It must adopt a rural, regional and social development approach that

	there are some areas of the country with little access to the benefits of new technology.	possibility of forming collaborations with other actors in the SNIA.	negotiating skills, technical level and market relationships of the different actors.	privileges broad dissemination of knowledge and its applications in solving problems of the different producers and agribusinesses.

Among the policy recommendations it is possible to derive from this integrative analytical framework, we would like to emphasize the following items that have already been discussed in the diagnostic:

1. The SNIA must have more resources, which are a prerequisite for designing and implementing programs with diversified objectives to promote innovation among different strata of producers, in order to reduce current differentials in productivity and competitiveness.
2. A regional perspective should be introduced to strengthen the capacities for innovation in areas that remain marginalized.
3. A new system of incentives is necessary to encourage knowledge generators to embrace a diversity of demands and propose effective solutions to the problems of producers and companies of different sizes.
4. It has already been mentioned that the institutional framework is very complete, but requires a major overhaul of the organization of the structures for its implementation, which are currently extremely complex and bureaucratic, which contributes to the uneven diffusion of its benefits, since only a few actors have the qualifications to manage innovation in this environment.
5. Innovation policy requires that shared socioeconomic objectives provide the motivation for better articulation of the SNIA and the space for designing more effective policy instruments than what now exists.