



Agricultural Waste Burning in Sonora

Factual Record regarding Submission SEM-16-001

Prepared in accordance with Article 15 of the
North American Agreement on Environmental Cooperation



Please cite as:

CEC. 2014. *Agricultural Waste Burning in Sonora. Factual Record regarding Submission SEM-16-001*. Montreal, Canada: Commission for Environmental Cooperation. 84 pp.

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ISBN: 978-2-89700-251-0

Disponible en español – ISBN: 978-2-89700-252-7

Disponible en français – ISBN: 978-2-89700-253-4

Legal deposit—*Bibliothèque et Archives nationales du Québec*, 2018

Legal deposit—Library and Archives Canada, 2018

Publication Details

Publication type: Factual Record

Publication date: September 2018

Original language: Spanish

Review and quality assurance procedures:

Final Party review: From 28 February to 3 May 2018

For more information:



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Acronyms and abbreviations

BECC	Border Environment Cooperation Commission
CARB	California Air Resources Board
CEC	Commission for Environmental Cooperation
CEDES	Sonora State Environment Commission (<i>Comisión de Ecología y Desarrollo Sustentable de Sonora</i>)
Cofepris	Federal Commission for the Prevention of Sanitary Risks (<i>Comisión Federal para la Prevención contra Riesgos Sanitarios</i>)
Conapo	National Population Council (<i>Consejo Nacional de Población</i>)
DDUE	Department of Urban Development and Environment of the municipality of Caborca (<i>Dirección de Desarrollo Urbano y Ecología</i>)
DOF	Official Gazette of the Federation (<i>Diario Oficial de la Federación</i>)
FAO	United Nations Food and Agriculture Organization
INEGEI	National Greenhouse Gas Emissions Inventory (<i>Inventario Nacional de Gases de Efecto Invernadero</i>)
INEM	National Emissions Inventory of Mexico (<i>Inventario Nacional de Emisiones de México</i>)
INIFAP	National Institute for Forest, Agriculture, and Livestock Research (<i>Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias</i>)
IPCC	Intergovernmental Panel on Climate Change
JPAC	Joint Public Advisory Committee
LEEPAS	Sonora State Environmental Protection Act (<i>Ley del Equilibrio Ecológico y Protección al Ambiente del Estado de Sonora</i>)
LGEEPA	Mexican Environmental Protection Act (<i>Ley General del Equilibrio Ecológico y la Protección al Ambiente</i>)
NAAEC	North American Agreement on Environmental Cooperation
NOM	Mexican Official Standard (<i>Norma Oficial Mexicana</i>)
OIAPES	Sonora State Office of Agricultural and Fisheries Information (<i>Oficina de Información Agropecuaria y Pesquera del Estado de Sonora</i>)
PICCA	Comprehensive Air Pollution Control Program 1990-1994 (<i>Programa Integral para el Control de la Contaminación Atmosférica 1990-1994</i>)
Proaes	Sonora State Attorney for Environmental Protection (<i>Procuraduría Ambiental del Estado de Sonora</i>)
ProAire-Sonora	Air Quality Improvement Program for the State of Sonora 2017-2026 (<i>Programa de Gestión para Mejorar la Calidad del Aire para el Estado de Sonora 2017-2026</i>)
Profepa	Federal Attorney for Environmental Protection (<i>Procuraduría Federal de Protección al Ambiente</i>)
Profyh	Caborca Fruit and Vegetable Producers' Association (<i>Asociación de Productores de Frutas y Hortalizas de Caborca, A.C.</i>)
RAMA	Automated Air Quality Monitoring Network (<i>Red Automática de Monitoreo Atmosférico</i>)
REEPMA	Environmental Protection Bylaw for the municipality of Caborca, Sonora (<i>Reglamento de Equilibrio Ecológico y Protección al Medio Ambiente de la municipalité de Caborca, Sonora</i>)
RPCCA	LGEEPA Air Pollution Prevention and Control Regulation (<i>Reglamento de la LGEEPA en materia de Prevención y Control de la Contaminación de la Atmósfera</i>)
Sagarhpa-Sonora	Sonora State Ministry of Agriculture, Livestock Production, Water Resources, Fisheries, and Aquaculture (<i>Reglamento de Equilibrio Ecológico y Protección al Medio Ambiente de la municipalité de Caborca, Sonora</i>)
Sagarpa	Ministry of Agriculture, Livestock Production, Rural Development, Fisheries, and Food (<i>Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación</i>)
Sedesol	Ministry of Social Development (<i>Secretaría de Desarrollo Social</i>)
SIAP	Agri-food and Fisheries Information Service (<i>Servicio de Información Agroalimentaria y Pesquera</i>)
UCAJ	Legal Affairs Coordinating Unit of Semarnat (<i>Unidad Coordinadora de Asuntos Jurídicos de la Semarnat</i>)
UNEP	United Nations Environment Program

Definitions

Agreement	North American Agreement on Environmental Cooperation
Caborca	Municipality of Caborca, Sonora
Controlled Burning Guidelines	<i>Guidelines establishing the ordinance regulating and authorizing the controlled burning of asparagus in the Caborca region, 2016-17 season</i>
Council	Council of the Commission for Environmental Cooperation
Guidelines	<i>Guidelines for Submissions on Enforcement Matters under Articles 14 and 15 of the North American Agreement on Environmental Cooperation</i>
Mexico	United Mexican States
NOM-015	Mexican Official Standard NOM-015-SEMARNAT/SAGARPA-2007, <i>Establishing the technical specifications for the use of fire on forested land and agricultural land</i> , published in the DOF on 16 January 2009
NOM-156	Mexican Official Standard NOM-156- SEMARNAT-2012, <i>Establishment and operation of air quality monitoring systems</i>
Notification	SEM-16-001 (<i>Agricultural Waste Burning in Sonora</i>), Article 15(1) Notification (27 February 2017)
November 2015 Minutes	<i>Minutes of the working meeting to establish the ordinance regulating the controlled burning of asparagus in the Caborca region, 2015-16 season</i>
Parties	The governments of Canada, the United States, and Mexico
Party	The government of Mexico
Resolution	SEM-16-001 (<i>Agricultural Waste Burning in Sonora</i>), Council Resolution 17-03, Instructing the Secretariat to prepare a factual record (9 June 2017)
Response	SEM-16-001 (<i>Agricultural Waste Burning in Sonora</i>), Party Response (5 September 2016)
Secretariat	Secretariat of the Commission for Environmental Cooperation
Submission	SEM-16-001 (<i>Agricultural Waste Burning in Sonora</i>), Revised Article 14(1) Submission (29 April 2016)
Submitter	Author of Submission SEM-16-001 (<i>Agricultural Waste Burning in Sonora</i>) [Submitter's name confidential pursuant to NAAEC Article 11(8)]
Working Meeting with the Secretariat	Meeting of 28 September 2017 in Caborca, Sonora, with representatives of the municipality of Caborca, Caborca Fruit and Vegetable Producers' Association (<i>Asociación de Productores de Frutas y Hortalizas de Caborca, A.C.</i> —(Profyh), and asparagus growers, among others

Units of measure, chemical elements, substances, abbreviations

CO	carbon monoxide
ha	hectare
HAP	polycyclic aromatic hydrocarbons
HC	hydrocarbons
km²	square kilometer
m	meter
NO₂	nitrogen dioxide
O₃	ozone

°C	degrees centigrade
Mg	Megagrams: one million grams (one metric ton)
t	Metric ton
Pb	lead
PM ₁₀	particles less than 10 microns (micrometers)
PM _{2.5}	particles less than 2.5 microns
TSP	total suspended particles
SO ₂	sulfur dioxide
Son.	Sonora
VOC	volatile organic compounds

Terminology

Mexican environmental law includes definitions to distinguish the various types of air pollution sources, which serve as a reference for determining the authority responsible for enforcing the law. It distinguishes sources, property, and zones, fixed sources, mobile sources, area sources, and other concepts. The following table provides the principal definitions found in the law, standards, and programs applicable to air quality management.

Term	Definition	Reference
Area sources	One or more activities distributed over a given area whose particular contributions, unlike fixed point sources, cannot be accurately identified and assessed. Area sources are too numerous and scattered to be efficiently included in a point source inventory.	National Air Quality Strategy 2017-2030
Fixed point source	In the language relating to air pollution, defined as “a fixed point of emission of large quantities of pollutants, generally of industrial origin.”	National Air Quality Strategy 2017-2030
Mobile source	Airplanes, helicopters, trains, trolleys, tractor-trailers, integral buses, trucks, automobiles, motorcycles, marine vessels, non-fixed equipment and machinery with combustion engines, and the like, which generate or may generate air pollutant emissions as a result of their operation.	RPCCA Article 6 paragraph V. See also LEEPAS Article 3 paragraph XXVIII.
Off-highway mobile sources	All automotive or portable equipment whose operation on public roads is prohibited. Examples of this category include construction and agricultural equipment, aircraft, locomotives, and commercial ships.	ProAire–Sonora

Note: In sources consulted by the Secretariat, crop residue burning, although not included in the definitions found in federal and state law, is considered an “area source.”

Notes of clarification

Due to the length of some of the Internet addresses cited in this document, Google Shortener <<http://goo.gl/>> was used to abbreviate the URLs. In each case, the functionality of the corresponding link was checked and the date viewed is specified.

Maps and other illustrations included in this factual record were produced from available sources, are not to scale, and are purely for purposes of illustration.

Unless otherwise indicated, all official documents cited in this factual record are contained in the archive of the Secretariat. The cited page numbers of the Submission and the Response refer to their original Spanish versions.



Photo: Courtesy of the Submitter.

Executive Summary

Date of revised submission: 29 April 2016

Submitter: [Name kept confidential pursuant to NAAEC Article 11(8) (a)]

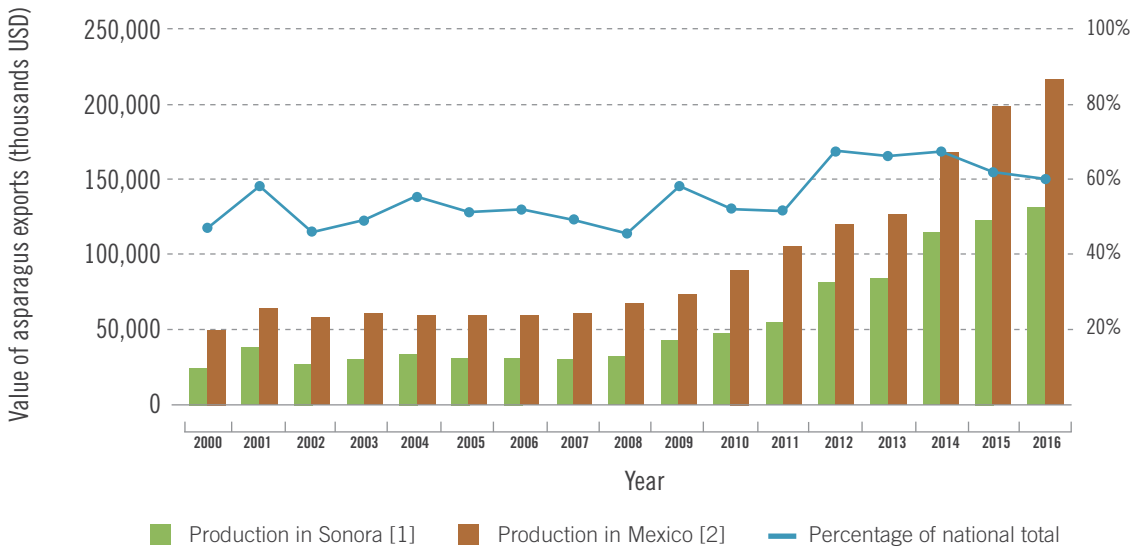
Assertion: Failure to control burning of crop residues from the 13,000 hectares of asparagus grown in Caborca, Sonora. The Submitter contends that these activities are being carried out in violation of provisions of the Environmental Protection Regulation (*Reglamento de Equilibrio Ecológico y Protección al Medio Ambiente—REEPMA*) of the Municipality of Caborca, Sonora.

Date of Council Resolution: 9 June 2017.

Scope of the factual record: Provide information on the effective enforcement of REEPMA provisions applicable to the implementation of air quality measurement systems and corresponding actions; the implementation of the measures necessary to prevent and control air pollution contingencies; the prohibition on pollutant emissions exceeding the maximum permitted levels applicable to the burning of crop residues; the issuance of crop residue burning permits; alleged harm to public health occurred during open-air burning.

Summary of relevant facts:

Mexico is the world’s third-largest producer of asparagus, growing a little over 170,000 tons per year (2014). The state of Sonora accounts for approximately 50% of Mexico’s asparagus crop. In 2017, the municipality of Caborca produced 74% of Sonora’s asparagus on an area of 10,171 ha.



See: Figure 8. Asparagus production in Mexico versus the state of Sonora

In order to stimulate its growth and to obtain more profitable results from production of the asparagus, once foliage is removed and shredded, it is then burned on December when its growth cycle has finished and the plants have dried.

Phenological stage	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Ferning out	[Green bar]							Burn season				
Crown dormancy											[Green bar]	
Flowering and fruiting	[Green bar]											
Drying of foliage and dormancy						[Green bar]						
Harvest									[Brown bar]	[Green bar]		

See: Figure 4. Stages in annual development of asparagus crop in Sonora

The smoke generated by biomass burning is a complex mixture of gases and particles that directly or indirectly affects both air quality and the global climate. The compounds making up this mixture are greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), criteria air pollutants such as carbon monoxide (CO) and nitrogen oxides (NO_x), and ozone precursors such as volatile organic compounds (VOC), which include carcinogens and mutagens like BTX (benzene, toluene and xylene). Particles can be divided into different fractions possessing a variety of effects, from reduced visibility to human health impacts.

None of the crop burning-related criterion pollutant emission inventories produced by official organizations specifically consider emissions from the burning of asparagus crop residues.



Photo: Courtesy of the Submitter.

The burning of asparagus foliage in the municipality of Caborca generates particle emissions (PM_{10} and $PM_{2.5}$) approximately equivalent to 10% of the particle emissions produced by the burning of all other crops in the state of Sonora, as reported in the National Emissions Inventory (INEM) for 2013. Similarly, this operation generates VOC and CO emissions equivalent to slightly more than 20% and 4%, respectively, of those reported by INEM 2013 for other crops in the state.

This results in PM_{10} and $PM_{2.5}$ emissions from asparagus burning in Caborca equal to 684 and 672.7 metric tons/year (t/year), well above those reported for Caborca in Semarnat's National Emissions Inventory for base year 2013 (36.2 and 34.4 t/year, respectively). $PM_{2.5}$ and PM_{10} emissions are associated with an increased incidence of respiratory diseases.

A satellite image shows dispersal of smoke from crop burning in the state of Sonora. One of the plumes is visible, covering a 10-km-by-30-km area slightly west and to the southeast of Caborca (named "Heroica Caborca" on the figure).



See: Figure 15. Satellite image of smoke dispersal from fires presumably of agricultural origin.

Burning in the vicinity of Caborca takes place at a distance between 3.5 and 25 km from the city. While the prevailing winds are from the east, north, northeast and northwest, low wind speeds in the region hinder the rapid dispersal of air pollutants. The burning closest to the city takes place about 4 km to the west.

The health authorities of the municipality of Caborca assert that there is no significant evidence that asparagus burning is a risk factor for respiratory disease. The Secretariat requested information from the authorities to corroborate this assertion; however, no evidence was provided.

At the time of writing of this factual record, no evidence of an air quality monitoring plan, project, or program consistent with the applicable law has been found.



Photo: Courtesy of the Submitter.

1. Background to the Submission

1. Articles 14 and 15 of the North American Agreement on Environmental Cooperation (the “NAAEC” or the “Agreement”)¹ provide for a process allowing any person or nongovernmental organization residing or established in Canada, the United States, or Mexico to file a submission with the Secretariat of the Commission for Environmental Cooperation (the “CEC Secretariat” or the “Secretariat”) asserting that a Party to the NAAEC is failing to effectively enforce its environmental law. The CEC Secretariat initially considers submissions to determine whether they meet the criteria contained in NAAEC Article 14(1). When the Secretariat finds that a submission meets these criteria, it then determines, pursuant to the provisions of NAAEC Article 14(2), whether the submission merits a response from the concerned Party. In light of any response from the concerned Party, and in accordance with NAAEC Article 15(1), the Secretariat may notify the Council that the matter warrants the development of a factual record, providing its reasons for such recommendation. Where the Secretariat decides that the existence of certain circumstances precludes the preparation of a factual record, it then proceeds no further with the submission.² Where the Council of the CEC so resolves, by a two-thirds vote of its members, the Secretariat produces a factual record as instructed by Council.
2. On 22 January 2016, a person whose name has been kept confidential pursuant to NAAEC Article 11(8)(a) (the “Submitter”) filed an NAAEC Article 14(1) submission with the Secretariat.³ The Submitter asserts that approximately 100 tons of asparagus crop residues generated on some 13,000 hectares of cropland near the municipality of Caborca, Sonora (“the municipality of Caborca” or “Caborca”) are burned each year. The Submitter contends that the burning violates the provisions of the Environmental Protection Bylaw (*Reglamento de Equilibrio Ecológico y Protección al Medio Ambiente*—REEPMA) of the municipality of Caborca, Sonora, and Mexican Official Standard NOM-015-SEMARNAT/SAGARPA-2007, *Establishing the technical specifications for the use of fire on forested land and agricultural land* (NOM-015).⁴
3. On 2 March 2016, the Secretariat found that submission SEM-16-001 (*Agricultural Waste Burning in Sonora*) did not meet the eligibility requirements of Article 14(1) of the Agreement and, based on paragraph 6.2 of the *Guidelines for Submissions on Enforcement Matters under Articles 14 and 15 of the North American Agreement on Environmental Cooperation* (the “Guidelines”),⁵ notified the Submitter of the commencement of a period of 60 working days in which to file a submission meeting all the NAAEC Article 14(1) requirements.⁶
4. On 29 April 2016, the Submitter filed a revised submission with the Secretariat, correcting certain assertions and presenting additional information in response to the Secretariat’s observations.⁷ The Revised Submission includes additional information concerning the environmental law cited in the original submission, a succinct account of the facts, and correspondence with the authorities concerning the matter.
5. On 13 June 2016, the Secretariat found that revised submission SEM-16-001 (*Agricultural Waste Burning in Sonora*) meets the eligibility requirements of Article 14(1) and requested a response from the government of Mexico in accordance with the criteria of Article 14(2).⁸
6. On 5 September 2016, the Secretariat received Mexico’s response, submitted in accordance with NAAEC Article 14(3) (the “Response”).⁹ After reviewing the Revised Submission in the light of the Response, the Secretariat found that Submission SEM-16-001 (*Agricultural Waste Burning in Sonora*) warranted the preparation of a factual record in regard to the enforcement of the provisions of the REEPMA, a municipal bylaw.
7. On 27 February 2017, the Secretariat notified the Council of the CEC (“Council”) that the Submission warranted the preparation of a factual record.¹⁰ The Secretariat found that the Response left central issues unresolved in relation to the effective enforcement of the REEPMA provisions applicable to the implementation of air quality measurement systems and the corresponding action measures; the implementation of the

measures necessary to prevent and control contingencies caused by air pollution; the prohibition on emitting pollutants in excess of the maximum permissible levels applicable to crop residue burning; the issuance of crop residue burning permits, and the alleged harm to public health occurred during open-air burning.

8. On 9 June 2017, via Resolution 17-03, the Council instructed the Secretariat to prepare a factual record for Submission SEM-16-001 “consistent with the terms recommended to the Council by the Secretariat in its Notification.”¹¹
9. In accordance with Article 15(5) of the Agreement, on 28 February 2018, the Secretariat submitted to Council the draft factual record for Submission SEM-16-001 (*Agricultural Waste Burning in Sonora*), commencing a period of 45 working days for the Parties to make observations on the accuracy of the document.
10. On 3 May 2018, Mexico submitted its comments on the accuracy of the draft factual record. On 8 and 9 May, the United States and Canada reported that they had no comments. In accordance with Article 15(6) of the Agreement, the Secretariat incorporated the relevant observations into the final version of the factual record on 18 June 2018 and submitted it to Council for a vote pursuant to NAAEC Article 15(7).



Photo: Courtesy of the Submitter.

2. Scope of the factual record

11. Pursuant to Council Resolution 17-03, this factual record addresses matters relating to the effective enforcement by the Municipal Council of Caborca of the following provisions of its environmental regulation:
 - REEPMA Articles 144, 146, and 172 with respect to the implementation of air quality measurement systems and corresponding action measures;
 - REEPMA Article 167 with respect to the implementation of the measures necessary to prevent and control contingencies caused by air pollution;
 - REEPMA Article 151 with respect to the prohibition on emitting pollutants in excess of the maximum permissible levels applicable to crop residue burning;
 - REEPMA Article 169, in reference to the issuance of crop residue burning permits;
 - REEPMA Article 170 with respect to the alleged harm to public health occurred during open-air burning.
12. The full text of Council Resolution 17-03 is presented in Appendix 1 of this factual record. The text of the REEPMA provisions addressed by this factual record is presented in Appendix 3.
13. NAAEC Article 21(1)(a) stipulates that each Party shall, at the request of the Council or the Secretariat, “promptly make available any information in its possession required for the preparation of a report or factual record, including compliance and enforcement data.” On this basis, the Secretariat requested information from Mexico for the preparation of this factual record, specifically in a letter of 20 July 2017 to the Caborca authorities.¹²
14. The Secretariat has considered the information provided by Mexico and, in accordance with NAAEC Article 15(4), has also considered relevant technical, scientific or other information that is publicly available, submitted by interested organizations or persons, or developed by the Secretariat or independent experts.

2.1 Environmental law in question

2.1.1 Enforcement context

15. As a preliminary note, and before this factual record examines the environmental laws in question, a review of and the structure of Mexican law, including constitutional provisions, and how they are intertwined and enforced generally must be provided. The general rule governing air pollution prevention and control is “the obligation to refrain from emitting air pollution,”¹³ pursuant to the Mexican Environmental Protection Act (*Ley General del Equilibrio Ecológico y la Protección al Ambiente*—LGEEPA) Article 113:¹⁴

Article 113. It is prohibited to emit pollutants into the atmosphere that cause or may cause ecological instability or harm to the environment. For all air emissions, the provisions of this act and the regulatory provisions ensuing from it, as well as the Mexican Official Standards issued by the Ministry, shall be observed.¹⁵

16. The municipality of Caborca has powers with which to control crop residue burning on its territory; enforce the REEPMA provisions applicable to the control of pollutant emissions; implement air quality monitoring, and apply the preventive measures necessary to avoid environmental contingencies. To distinguish Caborca’s sphere of jurisdiction in the area of air emissions, it is necessary to dwell on the principle known as *reserva de ley*, according to which powers not expressly vested in the federation are presumed to rest with lower orders of government. This principle is stated in Article 124 of the Mexican Constitution (*Constitución Política de los Estados Unidos Mexicanos*):

Article 124. Powers not expressly vested by this Constitution in federal officials are understood to be reserved to the states or to Mexico City, within the scope of their respective jurisdictions.

17. The same principle is found in LGEEPA Articles 7 paragraph XXII and 8 paragraph XVII, which apply to the determination of state and municipal jurisdiction.¹⁶
18. Pursuant to Article 115 paragraph III subparagraph (i) of the Mexican Constitution, matters under state jurisdiction can in turn be transferred to the municipalities:

Article 115. For their internal governance, the states shall adopt a republican, representative, democratic, secular, popular form of government, with the free municipality as the basis of their territorial division and their political and administrative organization, in accordance with the following considerations:...

III. The municipalities shall have responsibility for the following public functions and services:

i) *all such additional powers as may be determined by the local legislatures*, in keeping with the territorial and socioeconomic conditions of the municipalities as well as their administrative and financial capacity.¹⁷

19. The LGEEPA organizes the division of air emission-related powers by sources, property, and zones under federal and local jurisdiction in Articles 5, 6, 7, 8, and 9. These provisions also determine when powers are exercised exclusively or concurrently by these orders of government.¹⁸
20. LGEEPA Article 5 paragraph XII gives the federation the power to regulate—i.e., enact legislation—governing air pollution “from any type of emission source,” as well as to engage in pollution prevention and control with respect to emissions in “zones or, as applicable, fixed sources under federal jurisdiction.”¹⁹ Control of crop residue burning is not reserved to the federation for any category of sources, zones, or property.
21. State and municipal jurisdiction are established by LGEEPA Articles 7 and 8, respectively. These articles do not mention the powers relating to control of crop residue burning, which is therefore a residual jurisdiction not specified in the Act. LGEEPA Article 112 paragraph I provides as follows:

Article 112. In the area of air pollution prevention and control, the governments of the states, [Mexico City], and the municipalities, in accordance with the distribution of powers set out in Articles 7, 8, and 9 of this Act^[20] *and with the applicable local legislation*, shall:

I. Control air pollution in property and zones under local jurisdiction, as well as from fixed sources functioning as industrial, commercial, or service establishments, provided that that they are not enumerated in Article 111 *bis* of this Act;...²¹

VI. Establish and operate air quality monitoring systems, with technical support from the Ministry as applicable. The local governments shall file local air quality monitoring reports with the Ministry for incorporation into the National Environmental Information System;

VIII. Take the preventive measures necessary to avoid environmental contingencies caused by air pollution;

22. Article 4 paragraph III of the LGEEPA Air Pollution Prevention and Control Regulation (*Reglamento de la LGEEPA en materia de Prevención y Control de la Contaminación de la Atmósfera—RPCCA*) defines air pollution jurisdiction for zones and sources under state or municipal jurisdiction:

Article 4. Within their territories and *in accordance with the distribution of powers established by the local laws*, the federative entities and municipalities have jurisdiction over the matters contemplated in Article 6 of the Act, and in particular:...

III. The prevention and control of air pollution generated in zones or by emission sources under state or municipal jurisdiction.²²

23. Thus, LGEEPA Article 112 paragraph I and RPCCA Article 4 paragraph III establish that the *applicable local legislation* must be consulted to determine which authorities are responsible for air pollution control relating to sources, property, and zones not reserved to the federation. Agricultural land is not a fixed source functioning as an “industrial, commercial, or service establishment,” hence the burning occurring on this land falls residually under state jurisdiction, and Sonora state law has assigned this responsibility to the municipalities.
24. Articles 126 *bis* and 126 *ter* of the Sonora State Environmental Protection Act (*Ley del Equilibrio Ecológico y Protección al Ambiente del Estado de Sonora*—LEEPAS) establish a general prohibition on agricultural burning and give permitting responsibilities to the municipal authorities:

Article 126 *bis*. It is strictly prohibited to burn plant matter and matter growing on agricultural land, except where a controlled burning permit has been obtained from the competent municipal council.

Article 126 *ter*. The municipal councils, acting by their environment bodies, shall issue licenses to anyone who, having submitted a controlled burning plan, meets the requirements established by the same municipalities for mitigation of the impact on natural resources and adjacent properties.

25. Along the same lines, the LEEPAS gives the municipality the power to “suspend any permit that may have been issued, totally or partially, and temporarily or permanently, in the event of an extraordinary contingency caused by the burning, or where environmental conditions do not allow for adequate dispersal of pollutants” (LEEPAS Article 116, paragraph four).
26. Finally, LEEPAS Article 111 paragraph VI gives the state of Sonora and municipalities, “within the scope of their respective jurisdictions,” the responsibility for establishing and operating air quality monitoring systems.

2.1.2 Environmental law cited in the Submission

27. All the provisions addressed by the factual record are contained in a bylaw enacted by the Municipal Council of Caborca on 17 February 2014: the REEPMA.²³ This bylaw establishes provisions operating at different regulatory levels: i) provisions establishing enforcement criteria or enforcement principles, such as those listed in Article 144; ii) provisions vesting the competent authorities with emissions-related powers, which appear in Articles 146, 167, and 172, and iii) restrictions, e.g., the general prohibition on open-air waste burning and the conditions under which it may be carried out, which appear in Articles 151, 169, and 170.
28. REEPMA Article 144 establishes air pollution prevention and control criteria. While it does not contain specific obligations, these criteria serve as a guide to the Secretariat’s review of effective environmental law enforcement:

Article 144. For the prevention and control of air pollution, the following criteria shall be considered:

- I. Air quality shall be satisfactory in all human settlements and all areas of the municipality.
 - II. Air pollutant emissions, whether from artificial or natural sources, and whether from fixed or mobile sources, shall be controlled in order to guarantee air quality that is satisfactory for the well-being of the population and for ecological stability.
 - III. Protecting air quality is the responsibility of the municipality and of society at large.
 - IV. Programs concerning reforestation, verification of pollutant emissions, development of clean technologies compliant with environmental criteria, and soil protection shall be considered with a view to achieving environmental efficiency, so as to preserve the integrity and stability of the components of the atmosphere.
 - V. The preservation and sustainable use of the atmosphere is the joint responsibility of the authorities and the citizens.
29. For their part, REEPMA Articles 146, 167, and 172 provide that the competent authority in the area of air emissions is the Department of Urban Development and Environment (*Dirección de Desarrollo Urbano y Ecología*—DDUE) of the municipality of Caborca; they specify that this is the authority responsible for preventing and controlling environmental contingencies caused by air pollution and performing air quality monitoring, and they provide that it is also responsible for establishing and operating air quality monitoring systems:

Article 146. The [DDUE] shall have the following responsibilities, within the scope of its jurisdiction:

- I. To control air pollution on municipal property and in municipal zones, as well as from fixed sources under municipal jurisdiction that function as industrial, commercial, or service establishments.
- II. To apply the general criteria established by this Bylaw for the protection of the atmosphere, in municipal urban development plans.
- III. To require the parties responsible for the operation of fixed sources under municipal jurisdiction to refrain from exceeding the maximum permissible limits for pollutant emissions, in accordance with the applicable Mexican Official Standards, state environmental standards, and other environmental criteria or guidelines established in this Bylaw.
- IV. To establish and operate air quality monitoring systems, using technological devices compliant with the Mexican Official Standards and state environmental standards for this purpose.
- V. To produce environmental monitoring reports and keep them up to date.
- VI. To formulate and apply air quality management programs based on the Mexican Official Standards and state environmental standards, with a view to establishing environmental quality on the territory of the municipality.

[...]

Article 167. Where the air quality parameters established by the Mexican Official Standards are exceeded, the Municipal Council, acting by the [DDUE] and in coordination with the Municipal Civil Protection Unit, shall take the measures necessary to prevent and control environmental contingencies caused by air pollution for a given sector and/or for the whole population of the municipality.

Article 172. The Department shall establish and operate air quality monitoring systems with a view to evaluating the ambient air quality of population centers in accordance with the parameters set

out in the applicable Mexican Official Standards, with the technical support of the environmental authorities and the academic or research institutions, and shall deliver the local air quality monitoring reports to these entities for incorporation into the National Environmental Information System, in accordance with the applicable coordination agreements.

30. The REEPMA includes a prohibition on open-air burning where adverse health effects, harms, or nuisance occur (Art. 170) and provides that crop residues can be burned where a permit is obtained for this purpose (Arts. 151 and 169):

Article 151. The open-air burning of urban solid waste is prohibited, as is that of the vegetation resulting from the clearing, felling, or removal of topsoil from any land, for the purposes of construction or for any other purpose. The municipality may only approve such burning where it does not create an environmental risk or impact on air quality and it is deemed by the competent authorities to be justified on applicable grounds. The controlled incineration of any waste, with the exception of waste deemed hazardous by the [LGEEPA] or other federal legislation, shall remain subject to the emissions provisions of the state Act.

Article 169. To obtain the permit mentioned in the preceding article, the interested party shall apply to the Department in writing at least fifteen working days before the intended date of the event, with a copy to the competent agricultural authority and the municipal civil protection unit, fully justifying the necessity of the activity. The Department shall review the application and issue a decision within a period not to exceed fifteen working days, either unconditionally approving, conditionally approving, or denying the permit.

Article 170. The Municipal Council shall not permit open-air burning where toxic pollutants are generated that may cause adverse health effects, harms, or nuisance in the exposed population, nor in the case of urban solid waste. Any permit that has been issued may be suspended, in whole or in part, and temporarily or permanently, where an extraordinary contingency event is caused by the burning, or where environmental and meteorological conditions do not allow for adequate dispersal of pollutants.

2.1.3 REEPMA enforcement mechanism

31. The majority of the enforcement measures required by REEPMA have been taken in coordination between municipal authorities and the asparagus producers. The understanding on how to enforce REEPMA is documented in the *Minutes of the working meeting to establish the ordinance regulating the controlled burning of asparagus in the Caborca region, 2015-16 season* (the “November 2015 Minutes”)²⁴. In addition, the agreements recorded in the November 2015 Minutes were incorporated into the *Guidelines establishing the ordinance regulating and authorizing the controlled burning of asparagus in the Caborca region, 2016-17 season* (the “Controlled Burning Guidelines”).²⁵ The November 2015 Minutes included the following commitments:

- Monitoring of the burning carried out as agreed in the Meeting Minutes.
- Work meetings between the Office of the Sonora State Environmental Attorney (Procuraduría Ambiental del Estado de Sonora—Proaes) and the municipal president of Caborca, with the secretary of the Municipal Council, and with the environmental affairs coordinator of Caborca, with a view to reaching agreements on open-air burning in the municipality for the 2016–17 season.
- Convening a meeting with the farmers in the municipality “to propose research with the goal of improving burning practices so as to minimize the pollution generated by burning, as well as for the implementation of new final disposal practices for waste deriving from the asparagus crop.”²⁶



Photo: Courtesy of the Submitter.

32. On 28 September 2017, at the offices of the Asociación de Productores de Frutas y Hortalizas de Caborca, A.C. (Profyh), the CEC Secretariat’s legal officer took part in a meeting (the “Working Meeting with the Secretariat”).²⁷ At the Working Meeting with the Secretariat, the municipality of Caborca representatives reported that asparagus crop residue burning has been regulated on an ongoing basis for seven years under an agreement between the competent authorities and the asparagus growers. The information gathered during the Working Meeting with the Secretariat is presented in the section on the applicable environmental legislation (see sections 5, 6 and 7 of this factual record).

2.1.4 Applicability of NOM-015-Semarnat/Sagarpa-2007

33. The Controlled Burning Guidelines refer to the legal framework of NOM-015-SEMARNAT/SAGARPA-2007, *Establishing the technical specifications for fire use methods on forested land and agricultural land* (NOM-015). It must be specified that NOM-015 does not focus on air pollution control but rather on the management of fire to prevent and reduce the incidence of fires on forested land. The government of Mexico clarified this in its response:

Thus, while it is true that owners of agricultural land wishing to make use of fire must obey the provisions of NOM-015, it is also true that this Mexican Official Standard is not designed as a general regulation covering all uses of fire on agricultural land, but exclusively the possibility that fire on agricultural land may cause a forest fire due to its location near forest, which is not the case of the agricultural land in the municipality of Caborca.²⁸

34. In any event, the Municipal Council of Caborca authorities “consider NOM-015 as a parameter and a reference framework for crop residue burning.”²⁹ See, for example, the form prescribed for giving notice of controlled burning (Appendix 4) and the burning methods prescribed by NOM-015.

3. Description of the area of interest and the asparagus crop

3.1 Geographical situation, climate, population, and socioeconomic status of the region

35. The municipality of Caborca is located in northwestern Sonora; its seat is the locality of Caborca, and it is situated at 30°42' north latitude and 112°09' west longitude, at an altitude of 289 meters above sea level (Figure 1). It borders the United States to the north; the municipalities of Altar to the east, Pitiquito to the southeast, and Puerto Peñasco to the northwest, and the Gulf of California to the southwest. The territory of the municipality of Caborca constitutes an inclined plane running from north to south down to the Gulf of California. The region contains mountainous sections, including El Viejo, La Basura, Aquituni, La Campana, and Álamo Muerto.³⁰

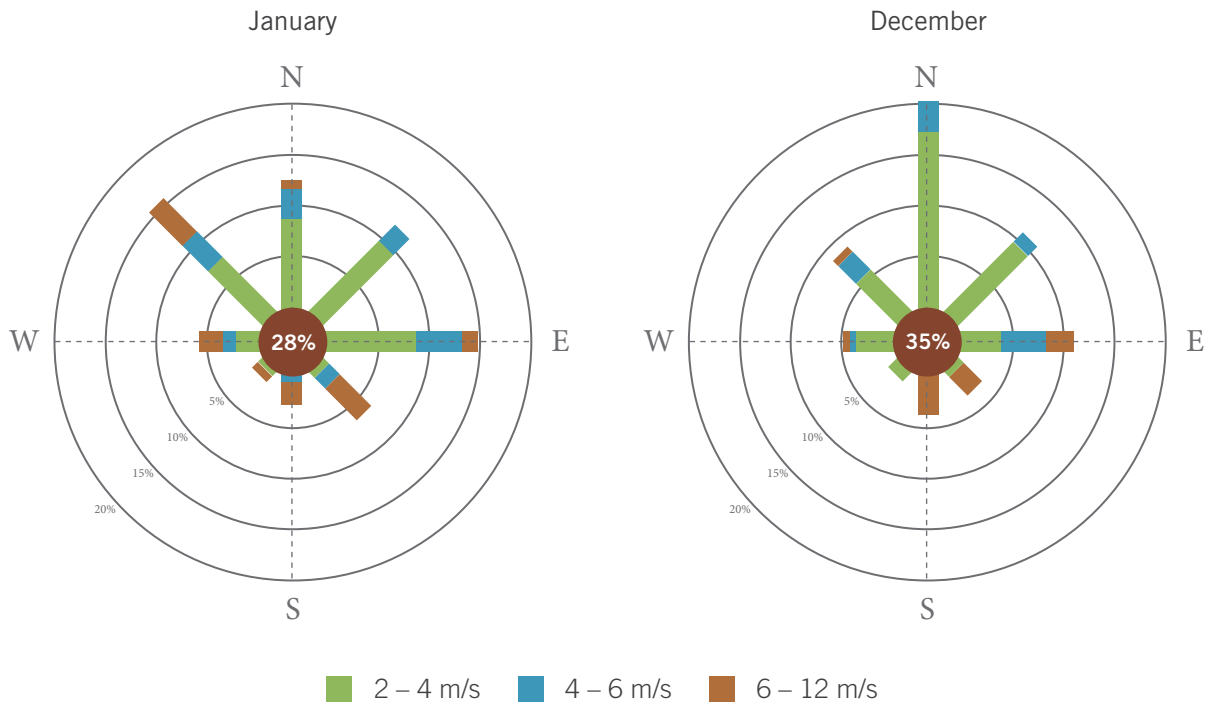
Figure 1. Location of the municipality of Caborca, Sonora



Source: Google Maps.

36. The municipality of Caborca has a hot desert climate, labeled BW (h) hw”(x)(e) in the Köppen-Geiger classification system, with a maximum mean monthly temperature of 31.9°C in the months of June to September and 12.4°C in December and January, and a mean annual temperature of 22.3°C. The rainy period occurs in the summer, in the months of July and August. Mean annual precipitation is 164 mm. Frost occasionally occurs in February.³¹ The relevant wind data for the asparagus burning period—December and January—was obtained from a weather station in the municipality of Caborca and is presented in the figure below.

Figure 2. Compass rose for Caborca, Sonora (average)



Source: Produced by the Secretariat with data from INIFAP, online at <<https://goo.gl/o2RtNF>> (viewed 30 November 2017). The means are calculated on the data for the months of December 2006, 2007, 2009, 2010, and 2011 and for the months of January 2007, 2008, 2009, 2010, and 2011.

37. Available climate data for Caborca shows that on December 21% of the recorded dominant wind blows from the north, while 35% corresponds to periods of no wind. In January the wind blows from the north-east (16%) while 28% of the time there are periods of no wind. Average wind speed is 3.2 m/s in December and 3.6 m/s in January.³²
38. The total population of Caborca in 2010 was 81,309, accounting for 3.1% of the population of the state of Sonora (Figure 3). In the same year, the municipality had 21,359 households, of which 4,999 (23%) were headed by women (Table 1). The average person aged 15 or over had 8.5 years of schooling. In 2010, 38.7% of the population lived in poverty (33.2% in moderate poverty and 5.5% in extreme poverty, see Figure 4).³³ According to Inegi data, 30% of the population, or 25,150 people, lacked access to health care that year.



Photo: Courtesy of the Submitter.

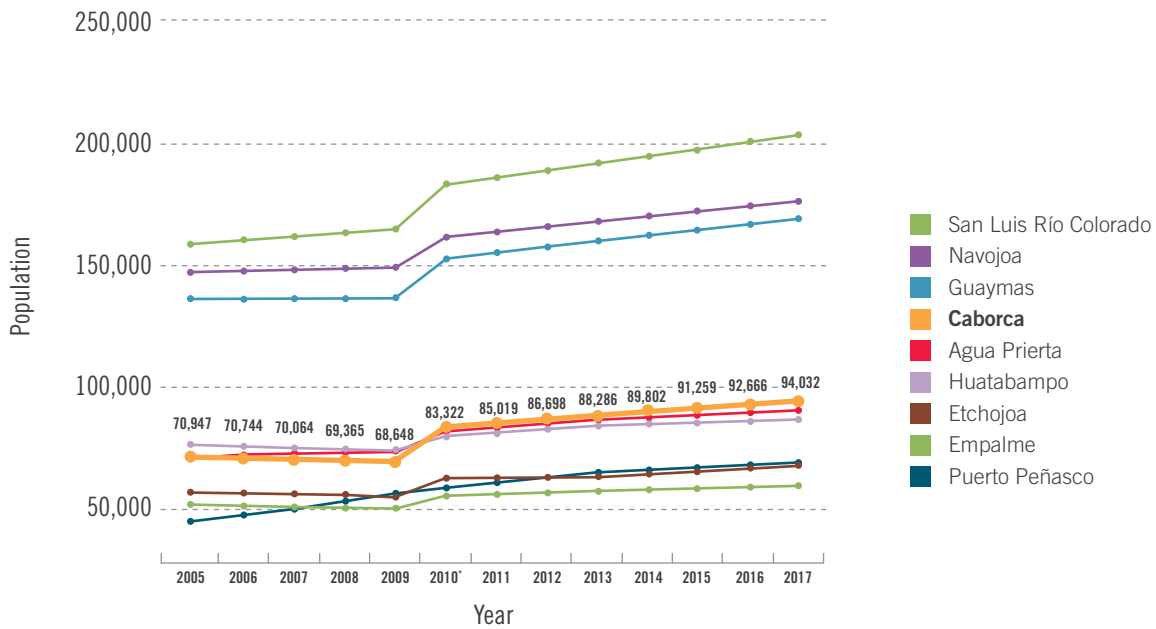
Table 1. Sociodemographic indicators (2010)

Indicator	Caborca	Sonora
Total population	81,309	2,662,480
Total inhabited private households and homes	21,359	705,668
Average size of household	3.7	3.7
Female-headed households	4,999	181,538
Average years of schooling for population age 15 or over	8.5	9.4
Medical personnel	118	5,399
Medical units	16	493
Average number of indicators for people living in poverty	2.4	2.4
Average number of indicators for people living in extreme poverty*	3.8	3.8

Source: Sedesol and National Council for Social Development Policy Assessment, Annual Report on Poverty and Social Disadvantage, 2010.

* Indicators: schooling, access to health services, access to social security, home quality and size, basic housing services, access to food.

Figure 3. Population of Caborca and other Sonora cities (2005–2017)

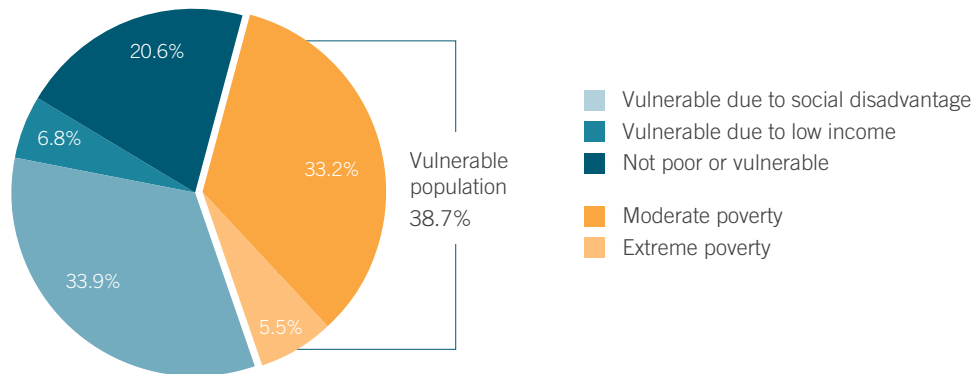


Source: Produced by the Secretariat with data from Conapo, Second Population and Housing Census (2005), and 2010 Census of Population and Housing.

Note: Values for 2005 to 2009 obtained from the Second Population and Housing Census (2005); for 2010 onward, from the 2010 Census of Population and Housing.

* We should note that according to data from Sedesol, Caborca had a population of 81,309 in 2010.

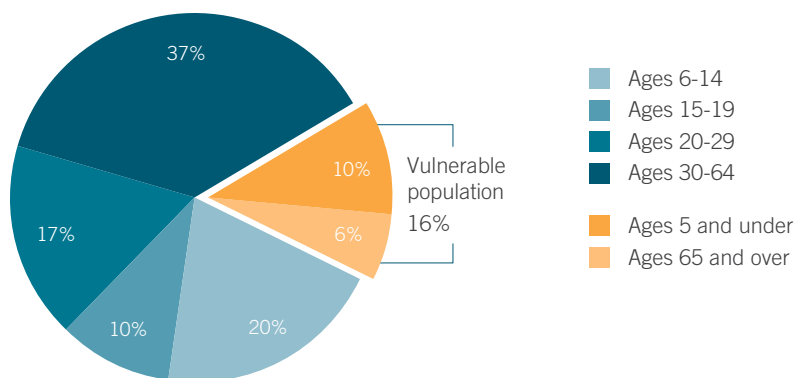
Figure 4. Multidimensional poverty measurement in Caborca (2010)



Source: Sedesol and National Council for Social Development Policy Assessment, Annual Report on Poverty and Social Disadvantage, 2010.

39. According to data from the State Population Council and the National Commission on Indigenous Peoples (2010), 8,139 people in Caborca were under five years of age while 4,627 were over 65 years of age. That is, 16% of the population were in groups considered most vulnerable to the effects of air pollution (Figure 5).³⁴

Figure 5. Age structure and vulnerability of Caborca population (2010)



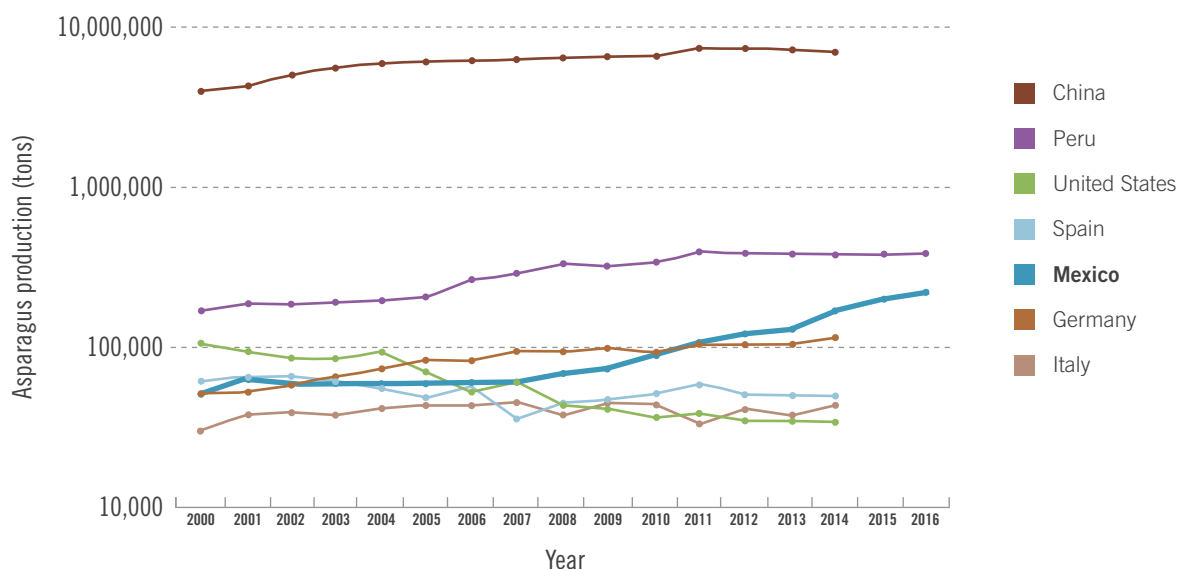
Source: Produced by the Secretariat with data from the State Population Council of the Sonora State Government, 2010 and the National Commission on Indigenous Peoples, Sociodemographic Indicators for the Total Population and the Indigenous Population, 2010.

Note: For the purposes of this figure, the "population vulnerable to air pollutant emissions" is considered to be adults over the age of 65 and children under the age of 5.³⁵

3.2 Asparagus production in Sonora

40. According to data from the United Nations Food and Agriculture Organization (FAO), in 2014 Mexico was the world's third leading producer of asparagus, with production of slightly over 170,000 tons, behind only China and Peru, which produced approximately 7 million tons and 380,000 tons, respectively. The growth of asparagus production is illustrated in Figure 6. Mexico has surpassed large asparagus growers—Spain in 2003, the United States in 2005, and Germany in 2011—and this growth pattern was continuing in 2016.

Figure 6. World asparagus production

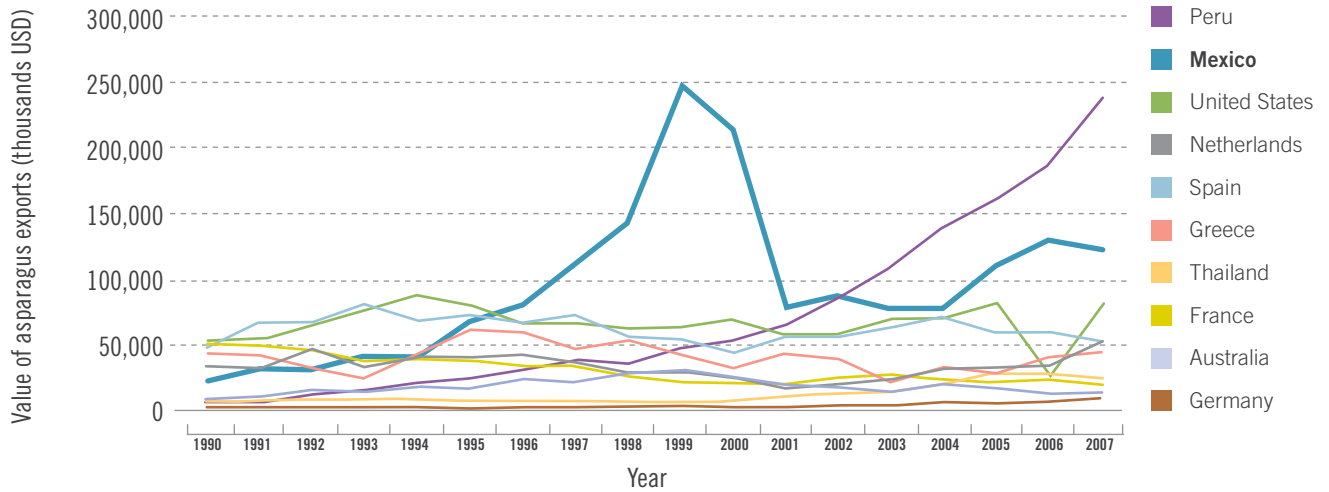


Source: Produced by the Secretariat with data obtained from FAO Statistical Databases by searching on “Production Quantity” and “Asparagus” for the years 2000 to 2014. For Peru, the 2015 and 2016 data is taken from Government of Peru, National Institute of Statistics and Informatics (2016), *Informe técnico núm. 2. Febrero 2017*, “producción nacional,” December, at 12. For Mexico, the 2015 and 2016 data is taken from Sagarpa, *Atlas agroalimentario 2017*.

41. Considering the value of asparagus exports, the world leaders have been Peru, Mexico, and the United States. Since 2003, Peru has been adding the greatest value to asparagus exports, followed by Mexico and the United States.
42. The continual increase in asparagus production in Mexico is due in part to the particularly high economic return on this crop. For example, a hectare of land sown to asparagus generates 25.5 times the value of the same land planted in corn.³⁶

43. Figure 7 shows that the value of exported asparagus from Peru steadily increased and surpassed Mexican exports in 2002. Moreover, in contrast with exports from other countries, Mexican export value peaked between 1998 and 2000. Production and commercialization of asparagus are affected by a number of factors which are not always constant (temperature, pests, transportation costs, labor, political factors, supply-demand tensions etc.) which may explain the peak in Mexican asparagus price.³⁷

Figure 7. Value of asparagus exports (1994-2007)



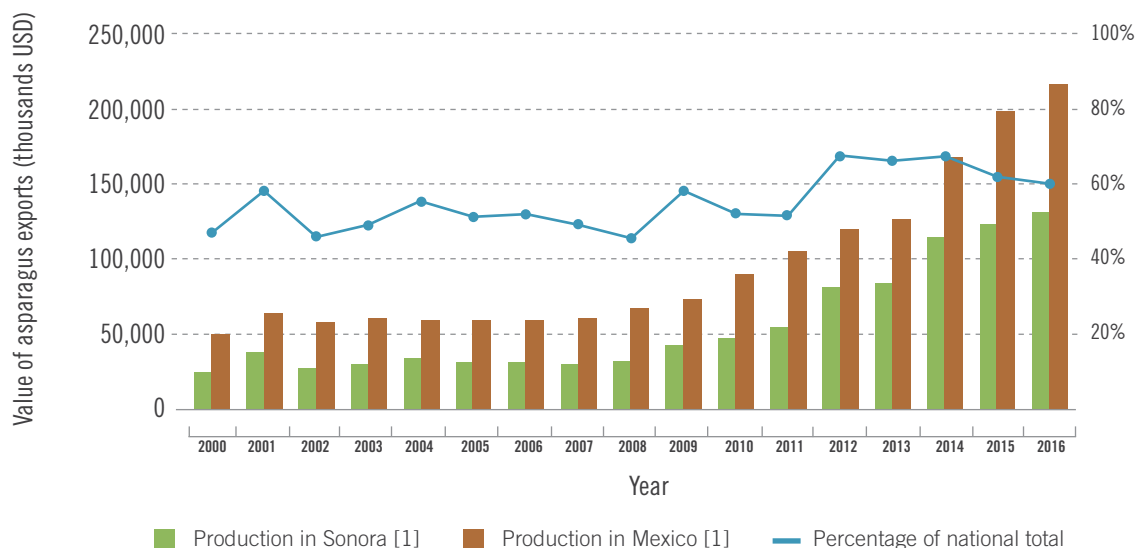
Source: Produced by the Secretariat with data from FAO Statistical Databases, May 2005-2010, available from the US Department of Agriculture at <<https://goo.gl/9WGJkR>> (viewed 24 November 2017).



Photo: Courtesy of the Submitter.

44. The state of Sonora's contribution has driven the growth of Mexican asparagus production. This is evident in Figure 8, which shows a significant correlation between the growth of Mexican and Sonoran production. In relative terms, Sonora's percentage of Mexican production has fluctuated around 50%, with a significant increase after 2010. In recent years, states such as Guanajuato, Baja California, Baja California Sur, and Querétaro have gone into asparagus growing as well, to the point that their combined contribution accounted for 36.6% of Mexico's production in 2016.³⁸

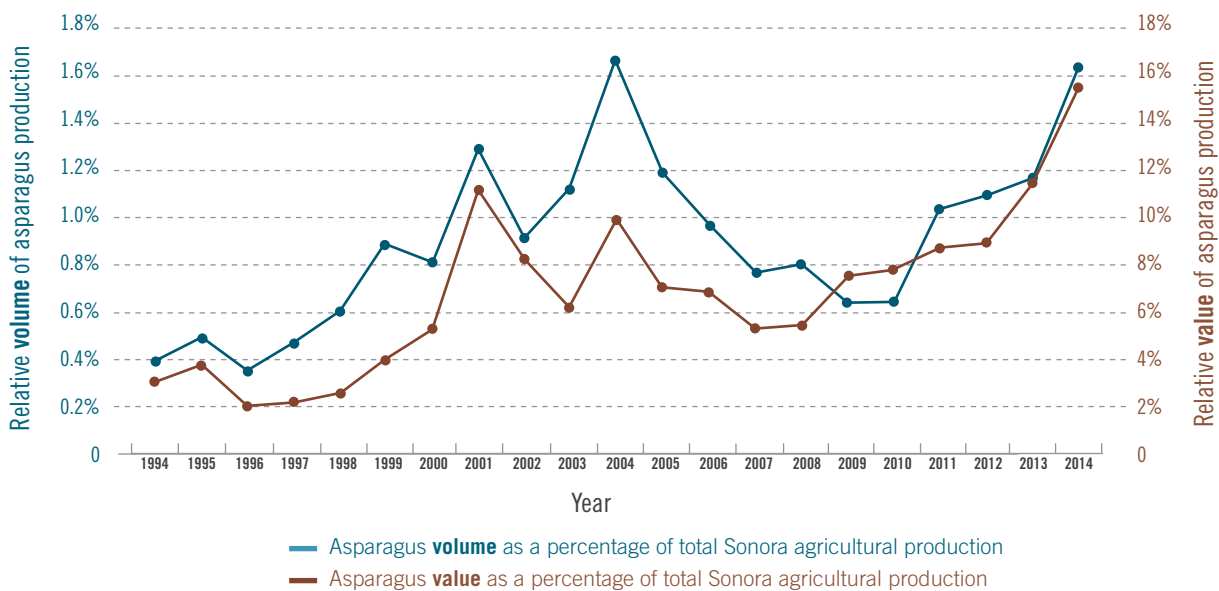
Figure 8. Asparagus production in Mexico



Source: Produced by the Secretariat with data from: [1] Sonora State Ministry of Agriculture, Livestock Production, Water Resources, Fisheries, and Aquaculture (*Secretaría de Agricultura, Ganadería, Recursos Hidráulicos, Pesca y Acuicultura del Gobierno de Sonora—Sagarhpa-Sonora*), Sonora State Office of Agricultural and Fisheries Information (*Oficina de Información Agropecuaria y Pesquera del Estado de Sonora—OIAPES*), *Información del sector agropecuario, pesquero y acuícola del estado de Sonora*, online at <<https://goo.gl/bvNp7h>> (viewed November 23 for agricultural subsector data, perennial crop “asparagus,” historical series), and [2] FAO Statistical Databases, data obtained by searching on “Production Quantity” and “Asparagus” for the years 2000 to 2014, online at <<https://goo.gl/862Vc2>> (viewed 23 November 2017). The 2015 and 2016 data is taken from Sagarpa, SIAP, online at <<https://goo.gl/Ng1fUK>> (viewed 21 November 2017).

45. The crop production guide for the state of Sonora produced by the federal Ministry of Agriculture, Livestock Production, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación—Sagarpa*) acknowledges the importance of the asparagus crop to the municipality of Caborca.³⁹ The document notes that over 7,000 hectares of asparagus are planted, almost all of it intended for export.⁴⁰ Asparagus is one of seven crops in whose production Sonora leads the nation.⁴¹ For Sonora, the foreign exchange generated by asparagus is topped only by wheat berries and grapes (see Table 2). In addition, Sonora is noted for its major contribution to world asparagus production, which, combined with the safflower and pecan crops, among others, makes it the leading Mexican state in terms of generation of foreign exchange from primary product exports.⁴² The total value of the Sonora asparagus crop in 2016 amounted to over 4 billion pesos, 14% of the total value of the state's agricultural production (see Table 2). Caborca ranks second among Sonora municipalities for the amount of value it adds to agricultural production.
46. Sonora's asparagus production and value has undergone considerable growth in the last decade, thereby augmenting the state's total agricultural production. Figure 9 presents the volume and value of asparagus production as a percentage of total agricultural production in the state.

Figure 9. Asparagus volume and value as a percentage of Sonora agricultural production (1994-2014)



Source: Produced by the Secretariat from data given in Sagarpa, SIAP, online at <<https://goo.gl/Ng1fUK>> (viewed 21 November 2017).

Table 2. Value of principal crops in Sonora

Indicator	Seed wheat	Grapes	Asparagus	Potatoes	Nuts
Value (in million pesos)	6,602	4,627	4,274	3,315	950
Percentage of total value for the state	21.9%	15.4%	14.2%	11%	3.2%
Volume (tons per year)	1,605,960	285,233	123,109	431,988	15,028

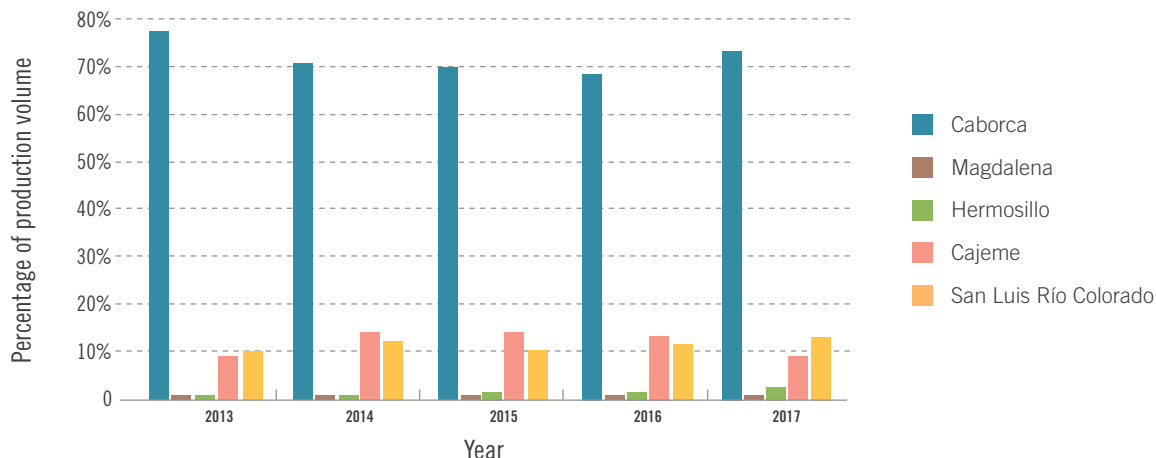
Source: SIAP (2016), *Sonora: infografía agroalimentaria 2016*, online at <<https://goo.gl/bQKFwE>> (viewed 23 November 2017).

47. In order to provide support for agricultural production, Mexico established state product systems committee, whose purpose is to make the production chain more efficient and profitable, and provide a basis for national agricultural development policies. Recently, the funding of these committees has been suspended.⁴³ In its place, growers' organizations have been leading the development of the sector.⁴⁴
48. Caborca is by far the state's largest asparagus-producing municipality. Figure 10 shows Caborca's notable contribution to asparagus production in Sonora.

Leading Sonora municipalities by value of agricultural production as a percentage of state total

- Hermosillo, 19.5%** (5,873 million pesos)
- Caborca, 16.6%** (5,011 million pesos)
- Cajeme, 12.4%** (3,727 million pesos)
- Navojoa, 8.0%** (2,416 million pesos)
- San Luis Río Colorado, 6.2%** (1,854 million pesos)

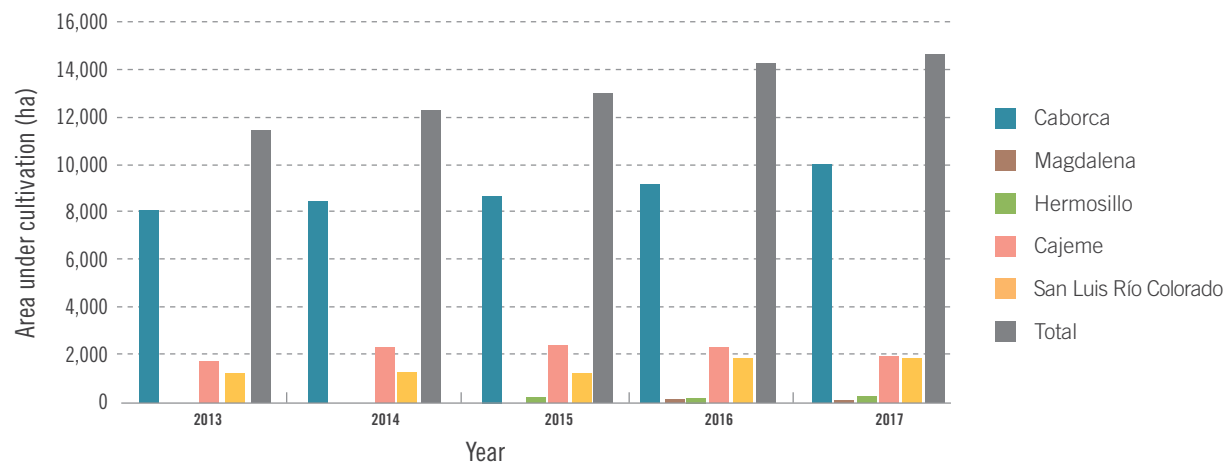
Figure 10. Asparagus-producing municipalities in Sonora, by production volume



Source: Produced by the Secretariat with data from Sagarhpa-Sonora, OIAPES, *Información del sector agropecuario, pesquero y acuícola del estado de Sonora*, online at <<https://goo.gl/bvNp7h>> (viewed November 23, data downloaded by selecting “Agrícola,” “Producción agrícola,” “Serie Histórica por Cultivo de Perennes,” and then “Espárrago” under “Cultivos”).

49. As to the area under asparagus cultivation, here again the municipality of Caborca is dominant (Figure 11).

Figure 11. Asparagus-producing municipalities in Sonora, by area under cultivation



Source: Produced by the Secretariat with data from Sonora State Government, Sagarhpa-Sonora, OIAPES, *Información del sector agropecuario, pesquero y acuícola del estado de Sonora*, online at <<https://goo.gl/bvNp7h>> (viewed November 23, data downloaded by selecting “Agrícola,” “Producción agrícola,” “Serie Histórica por Cultivo de Perennes,” and then “Espárrago” under “Cultivos”).

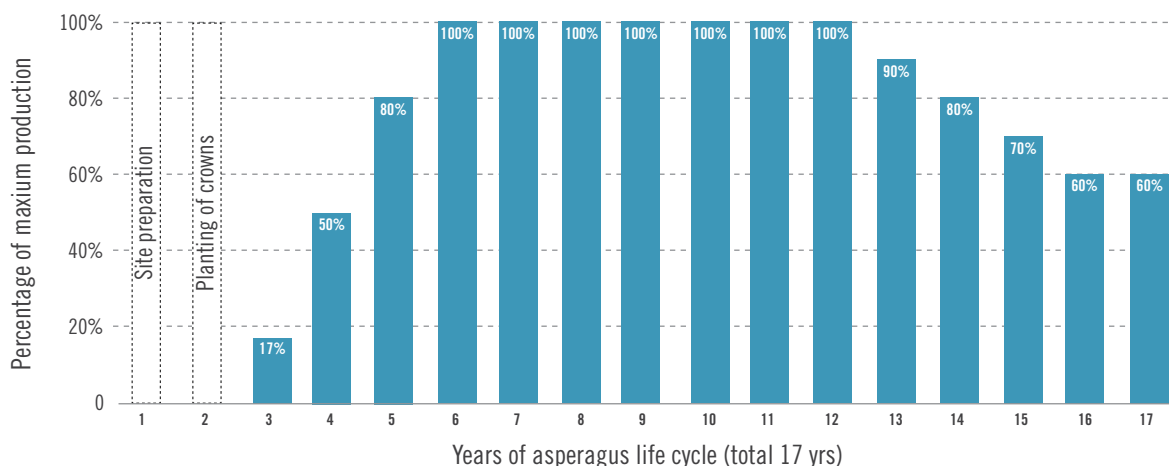
49. This area has grown steadily, from 8,290 ha in 2013 to 10,171 ha in 2017.⁴⁵
50. As indicated, nearly the entire asparagus crop is exported. Peruvian asparagus starts arriving in the United States and Canada in May, and imports continue until mid-January. At that point, asparagus imports from Caborca and central Mexico start reaching these countries and continue into the summer.⁴⁶

3.3 Asparagus growing and harvesting methods in Caborca

3.3.1 Overview

51. Asparagus is a high-value crop. It is also considered a *gourmet* product considered to have nutritional properties, for it contains vitamins A, C, B₁, B₂, and E; minerals such as calcium, iron, phosphorus, and potassium; dietary fiber, and asparagine, a non-essential amino acid with diuretic properties.⁴⁷
52. Asparagus is the first spring crop to be ready for harvest, but the harvest only lasts for a short period of eight to twelve weeks. The main harvest season occurs in the spring in the State of California, although fall harvests are also possible.⁴⁸ Unlike the majority of crops, asparagus is a perennial that can be productive for 15 years or more (see Figure 12). Its high price is due to the costs of growing, harvesting, and processing the product as well as the substantial investment needed to establish asparagus beds,⁴⁹ without considering the required investment in land and machinery.⁵⁰ For these reasons, any decision to grow asparagus commercially requires a careful evaluation.⁵¹
53. Harvesting may start six days after burning. Burning is a practice in some asparagus producing regions such as Peru, but it does not occur in other regions in North America, such as California and Quebec.⁵² The following sections explain how asparagus spears grow from rhizome (crown) in a matter of days once the growing season is triggered with burning. This is controlled in such fashion that heat does not destroy the crown and instead, warms-up the soil to stimulate spear growth.

Figure 12. Asparagus life cycle, by percentage of maximum production attained each year



Source: Produced by the Secretariat with data from B. Dartt *et al.*, *Cost of asparagus production in West Michigan*, Staff Paper 2002-42, Michigan State University, Department of Agricultural Economics, online at <<https://goo.gl/C4Ab7n>> (viewed 5 December 2017).

3.3.2 Climate for asparagus production

54. Asparagus production has proven more successful in areas where frost or drought halts the growth of the plants at season's end, when they enter a period of dormancy. Without this period, asparagus plants would not produce enough spears to be profitable. Asparagus growth range is between 6°C to 38°C. The optimal temperature for spear formation is 11-13°C, while the optimal temperature for spear growth is 18-25°C.⁵³ Asparagus can be grown in a wide variety of soils but prefers fertile, medium-textured, well-drained soils in humid temperate regions with long growing seasons and sufficient light to allow for a lengthy period of photosynthesis.⁵⁴

3.3.3 Site selection and preparation

55. Produced in many regions of the world, asparagus can grow in soil textures ranging from coarse sandy to fine clay. Highest yields are typically obtained in medium-textured sandy loams and in loamy soils. Since asparagus plants have deep root systems ranging down below 1.8 m, shallow soils or soils with high water tables should be avoided, since the roots of the plant do not tolerate saturated soil.⁵⁵

3.3.4 Asparagus varieties

56. Of over 150 species of asparagus, only one, *Asparagus officinalis*, is edible. This species has a large number of varieties around the world. Commercial asparagus varieties have to be high-yielding and disease-resistant. In Caborca, where five varieties have been used, the most common is Brock. Also present are Early California, UC115, Atlas, and a local selection of Early California called Early C-S. Brock accounts for 50% of the Caborca asparagus crop. This variety is harvested during a three-month window running from early January to late March. The harvest ends when the temperature rises in late March; when daily maximums exceed 30°C and minimums do not go below 20°C, spear quality declines significantly.⁵⁶ Table 3 presents a summary of asparagus varieties used in Caborca.⁵⁷

Table 3. Asparagus varieties grown in Caborca, Sonora

Variety	Spear quality	Cycle
Brock	Good	Early
UC-157	Very good	Intermediate
UC-115	Very good	Intermediate
Atlas	Very good	Late
Early California	Good	Very early
Jaleo	Very good	Early

Source: INIFAP (2010), *Guía técnica para el área de influencia del campo experimental Costa de Hermosillo*, Table 38, p. 127. Centro de Investigación Regional del Noreste, Campo Experimental Costa de Hermosillo, Hermosillo, Sonora, Mexico, online at <<https://goo.gl/2HFMDt>> (viewed 5 December 2017).

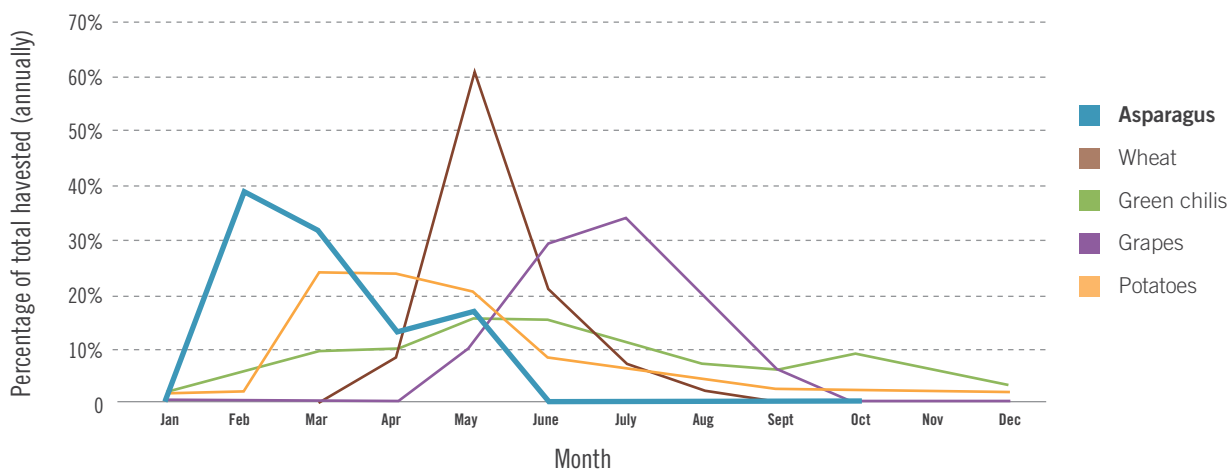
3.3.5 Planting

57. Normally, asparagus can either be direct-seeded or its rhizome (crown) can be transplanted from a field nursery.⁵⁸ After planting, the plant needs time to mature before a crop can be taken off. Production begins in three to four years for direct-seeded plants or two years for transplanted ones. Since the crop is perennial, it does not need to be replanted every year. The same plant can produce for 15 years or more, although it is recommended to renew the plantation every ten years.⁵⁹

3.3.6 Annual crop cycle

58. Asparagus is generally available between January and April. Figure 13 presents the main crops in Sonora; it shows that the highest annual production occurs in March.

Figure 13. Availability of main Sonora crops



Source: Produced by the Secretariat with data from *Información del Sector Agropecuario, Pesquero y Acuícola del Estado de Sonora* (8 November 2016), Subsector Agrícola, at 4, online at <<https://goo.gl/Jv5Knr>> (viewed 5 December 2017).

59. Asparagus availability also depends on the origin of the product. Caborca, Mexicali, and San Luis Río Colorado produce from January to March; the Mexican Bajío, from June to September, and Comondú and Ciudad Constitución (both in Baja California), from March to April and from October to December.
60. In places where production occurs between January and March, following the harvest, the asparagus plants are left to continue growing. It is then, during March and April, the spears grow into a tall, feathery, branching plant (called “ferns”) that can reach a height of 1.5 meters (see photographs on p. 27). During this stage of its development, the plant replenishes its store of carbohydrates in the crown and the roots; this being the case, it has an increased demand for nutrients and water. If these are in short supply, the result is a long-term decline in production and life expectancy.⁶⁰ Without applications of nitrogen fertilizer in particular at this stage, the nitrogen reserves built up in the crown would continue to decline, as they do during the harvest.



Photo: Commission for Environmental Cooperation.

Foliage growth following harvest.



Photo: Courtesy of the Submitter.

Spraying with Hagie machine.



Photo: Courtesy of the Submitter.

Site preparation in November.

61. It takes three months after the end of the harvest for the plant's nitrogen and carbohydrate reserves to return to pre-harvest levels. In cold climates, the quantity of reserves exhibits little or no decline until the following spring. Table 4 presents a summary of the annual cycle of the asparagus plant in Sonora.

Table 4. Annual growth cycle of asparagus in Sonora

Phenological stage	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Ferning out	■							Burn season				
Crown dormancy											■	
Flowering and fruiting	■											
Drying of foliage and dormancy						■						
Harvest									■		■	

Sources: Adapted from S. Carreón (2014), *Experiencia en la producción de espárrago en Misión del Bisani*, report of work experience, Graduate Faculty, Universidad Nacional Autónoma de México; C. Navarro Aínza (2002), *Tecnología para el manejo del espárrago en el noroeste de Sonora*, National Institute for Forest, Agriculture, and Livestock Research (*Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias—INIFAP*), Regional Research Center of the Northeast, Experimental Field in Caborca (*Centro de Investigación Regional del Noroeste, Campo Experimental Región de Caborca*), Mexico at 6.

62. Foliage growth is interrupted by cutting off the water supply in late October. Since Caborca is an arid region, the foliage dries down and the plant enters a period of dormancy, which helps improve production. Drying takes a little over a month, so that the work of preparing the harvest can begin by mid-December.
63. Although the Secretariat did not confirm that all preparation activities described below actually take place in Caborca, Sonora, the Secretariat presents the general process according to consulted sources (see photographs below). The preparation stage begins with foliage (fern) removal. The foliage is mowed at ground



Fotos: Courtesy of the Submitter.

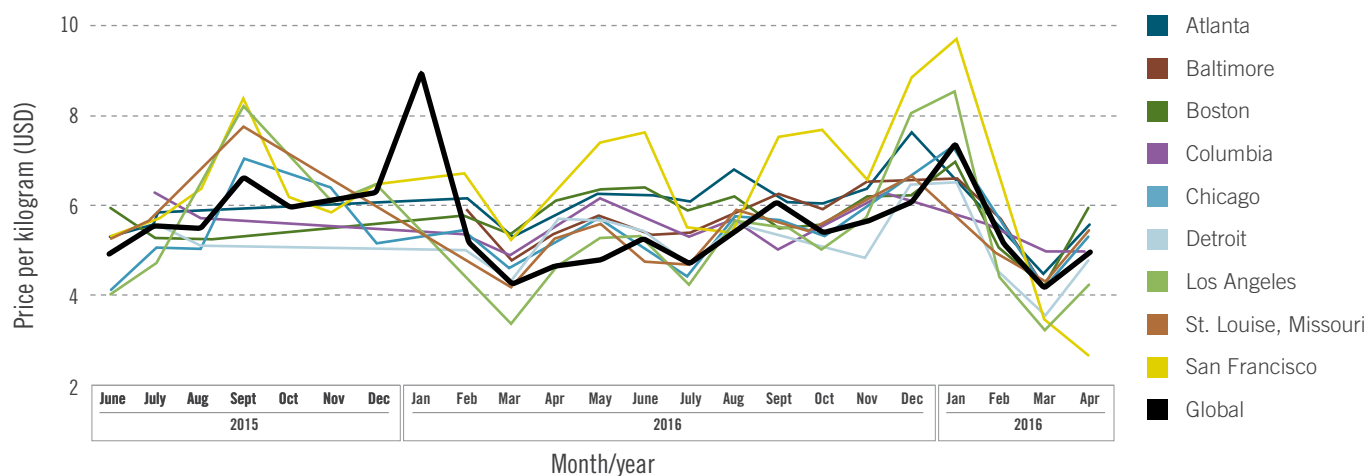
Foliage growth, burning, and asparagus spears growing.

level and chopped [re burning, see paragraph 65 *infra*]. The practice reduces the plant's vegetative burden, facilitates incorporation of organic matter into the soil, makes room for the harvest implements, and reduces the pest population in the soil. The University of Minnesota asparagus production guide suggests mowing the asparagus plants, adding phosphorus and potassium fertilizer, and shallow disking so as not to damage the crowns.⁶¹ Disking must be done immediately to avoid wounding the new spears before they emerge, which would also give disease organisms a point of entry into the spears. In addition, the guide recommends a pre-harvest herbicide application to reduce or prevent the establishment of winter annuals or other weeds not destroyed by disking. There are specialized flail mowers that leave the ground covered with mulch and ready for disking.⁶²

3.3.7 Burning of asparagus crop residues

64. A guide published by the University of Delaware suggests burning any dry brush remaining after a frost in order to eradicate such fungal diseases as purple spot and rust. It also states that if the brush is not burned off, then it should be mowed, chopped, and shallow-disked as discussed above.⁶³ Agricultural burning is normally associated with phytosanitary measures to prevent plant disease; however, in the case of asparagus production in Caborca, this method is also used to stimulate plant growth early in the season and take advantage of better asparagus prices in the market.
65. The asparagus growers of Caborca state that fields must be burned a week after mowing to eliminate pests.⁶⁴ This assertion, documented by a study, states that burning produces the following benefits:⁶⁵
 - Harvest can begin six days earlier.
 - Production is greater during the first two weeks.
 - Propagules of *Cercospora*- and *Stemphylium*-caused pathogens (which erupted in places where rain precluded burning) are reduced.
66. It must be noted that, however, that total asparagus production data show no significant difference between production volumes with and without burning.⁶⁶
67. As noted above, another reason for burning asparagus crop residues is to obtain an earlier harvest, which is advantageous because midwinter prices are higher.⁶⁷ The heat from the burn induces the crown to enter an active phase of growth and begin producing spears, even in cold temperatures. Moreover, the black ash sitting on top of the soil absorbs more solar radiation, so that the heating effect continues even after burning is finished.⁶⁸ Soil heating is also employed for this purpose in Europe, but hot-water pipes are used there instead of burning.⁶⁹
68. Several authors mention the commercial benefit of harvesting asparagus earlier to take advantage of high prices in January and February (Figure 14),⁷⁰ and these are indeed the months of the Caborca harvest season when the market is at its strongest. California asparagus comes onto the market in February and March, causing prices to decline.⁷¹
69. The phytosanitary benefit is a consequence of burning, in that fire destroys fungal spores that might otherwise be propagated in the crop residues; e.g., *Fusarium*, one of the most common plant diseases in the Caborca region.⁷²

Figure 14. Price of imported asparagus in the United States (2015-2016)



Source: Produced by the Secretariat based on data from the Ministry of the Economy (*Secretaría de Economía*), National Market Information and Integration System (*Sistema Nacional de Información e Integración de Mercados*), online at <<https://goo.gl/8oTGmQ>> (viewed 21 November 2017).

70. In the Bajío region, and particularly in the municipality of San Luis de la Paz, which accounts for 27% of the production in Guanajuato state,⁷³ agricultural burning was banned by Article 96 of the Environmental Protection Bylaw (*Reglamento de Protección al Ambiente*).⁷⁴ In the state of Arizona, open outdoor fires are not allowed except for agricultural burning and only for the purpose of disease and pest prevention, which require a permit prior to conducting this activity.⁷⁵ In Imperial County, California, a permit is required prior to agricultural burning season, but even with a permit in place, a person shall not conduct burning unless a permissive burn day is issued⁷⁶ and in San Diego County, California a 15-day valid permit may be issued which conditions include prior notification requirement and conditions of the agricultural material to burn.⁷⁷

3.3.8 Weed control

- 71. Asparagus is a dioecious species, which means that there are male and female plants. In general, female plants produce broader spears than male plants, while the latter produce a larger number of smaller-diameter spears. Only female plants produce berries.⁷⁸
- 72. To replenish the carbohydrate reserves in the roots, asparagus plants must produce foliage after the harvest season. Female plants produce seeds at this time, and these become the source of volunteer seedlings in subsequent years.⁷⁹
- 73. Volunteer asparagus plants are small in diameter and unsalable; they interfere with the commercial harvest because their growth period is out of phase with that of the parent plants. Taken together, these factors interfere with optimal production. Volunteer seedlings develop foliage at the start of the harvest season. They provide a reservoir for asparagus aphids, which can thus develop populations two to three months earlier than in volunteer-free fields.

74. Volunteer plants are hard to control in established asparagus plantations. Surface tillage can control their growth without damaging the crowns of the commercial plants, since these are perennial and mostly rooted deeper in the soil. However, tillage during harvest would damage the commercial spears. Post-harvest tillage might destroy volunteers, but it would also impede fern growth and hence replenishment of crop root reserves; furthermore, it would damage any shallowly rooted crowns, creating entry points for pathogens.
75. Asparagus spears produced from male hybrids tend to be quite uniform. The main benefit of a totally male hybrid variety is that it does not produce seeds, thus eliminating the volunteer problem.
76. There do exist some completely male asparagus varieties. These have been tested by growers in the northwestern United States, mainly in Washington state. Seed production for these male hybrids is based on vegetative propagation of the parents.⁸⁰
77. Herbicides can be used for selective control of volunteers in established asparagus crops, since volunteer seedlings are probably more susceptible to many herbicides than well-established plants.
78. It has been found that herbicides such as metribuzin; chloramben (3-amino-2,5 dichlorobenzoic acid), and chlorbromuron (3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea) damage asparagus grown from seed and can be used to control asparagus volunteers. The following herbicides partially control volunteers in spray-irrigated crops: trifluralin (2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)aniline); simazine; terbacil, and metribuzin. For poorly irrigated asparagus, trifluralin, metribuzin, and napropamide are used.
79. According to information provided by the legal advisors of Profyh, the Caborca asparagus growers have at their disposal a range of pesticides approved by the Federal Commission for the Prevention of Sanitary Risks (*Comisión Federal para la Protección de Riesgos Sanitarios—Cofepris*).⁸¹ At the Working Meeting, the growers asserted that they adhere to pesticide application rules very strictly because the product is exported to the United States and must comply with that country's rigorous standards.
80. No specific information was obtained about the chemicals applied prior to the burn, but there is evidence that certain chemical residues in the brush can produce persistent organic compounds of environmental concern when burned.⁸² For example, copper hydroxychloride, used for control of fungal diseases such as purple spot,⁸³ contains not only chlorine but also copper, which acts as a catalyst for dioxin formation.⁸⁴



Photo: Courtesy of the Submitter.

4. Measures taken by Mexico to effectively enforce REEPMA Articles 144, 146, and 172 with respect to the implementation of air quality measurement systems and corresponding action measures

81. The Submitter asserts that asparagus crop residue burning is taking place in the municipality of Caborca, Sonora, and that it is “impossible to ascertain the degree to which the maximum permissible limits for air quality established by the applicable laws are being exceeded.” The Submitter contends that the municipality of Caborca is failing to effectively enforce REEPMA Articles 144, 146, and 172, which establish air pollution prevention and control criteria, the relevant powers of the DDUE, and the obligation of this body to establish and operate air quality monitoring systems.⁸⁵
82. As described in detail above at paragraphs (section 2.1.2) REEPMA Article 144 establishes air pollution prevention and control criteria, while REEPMA Articles 146 paragraph IV and 172 establish the scope of the DDUE’s jurisdiction to control, establish, and operate air quality monitoring systems and issue local air quality monitoring reports for inclusion in the National Environmental Information System (*Sistema Nacional de Información Ambiental*).
83. The National Air Quality Strategy 2017–2030 defines an air quality monitoring system as a “set of stations and instruments for the systematic collection and evaluation of environmental samples such as air.”⁸⁶ The environmental standards define air quality monitoring as the “set of methodologies designed for continuous and systematic sampling, analysis, and processing of concentrations of substances or pollutants in air.”⁸⁷ The purpose of a monitoring system is to provide timely information to the public and the authorities, who can then make the appropriate decisions to protect public health and the environment; to assess patterns and determine whether air quality has declined or improved over time; to evaluate the results of pollution control programs and measures, and to populate and corroborate air quality models, *inter alia*. For the siting of monitoring stations, factors such as population density, distribution of emission sources, weather, and topography are taken into account, in addition to the goal of the monitoring campaign.⁸⁸ The documents of the 2017–2026 Sonora State Air Quality Improvement Program (“ProAire–Sonora”) define monitoring as “periodic measurement to determine pollution levels in various environments.”⁸⁹
84. Air quality management in Mexico is standardized by means of a group of air quality management programs by areas (states, air basins or cities) known as ProAire. These programs establish actions to be taken in order to control or reduce air pollutants emitted by human activities in a given region that have an impact on health and the environment.⁹⁰ Air quality measurement commenced in 1958⁹¹ but it was not until 1971 that the first manual air quality monitoring network was installed in Mexico City; this gave way in 1986 to the Automated Air Quality Monitoring Network (RAMA). The Comprehensive Air Pollution Control Program (*Programa Integral para el Control de la Contaminación Atmosférica 1990-1994—PICCA*), the first formal program of its kind, provided a basis for developing and implementing a systemic and comprehensive program whose general purpose was to protect public health: the 1995-2000 Air Quality Improvement Program for the Valle de Mexico (*Programa para Mejorar la Calidad del Aire en el Valle de Mexico*); i.e., ProAire.⁹²
85. There are currently thirty ProAire programs in the country.⁹³ The ProAire–Sonora was published prior to the finalization of this factual record. At the municipal level, the city of Nogales in Sonora has a program in effect,⁹⁴ Caborca does not. It should be noted that the Secretariat had access to the draft ProAire–Sonora report prior to its publication while developing this factual record, and that the final version did not contain changes to the data that are presented here.

86. In Sonora, air pollution monitoring has been irregular since 1989, being performed within the framework of the Border Environmental Program and the Mexican Environmental Program. Measurement activities have been carried out in eleven Sonora municipalities, but not in the municipality of Caborca.⁹⁵ Despite the state of Sonora's efforts to put air quality measurement into practice, only the Nogales and Hermosillo stations are currently producing PM₁₀ and PM_{2.5} data. While data does exist for the Agua Prieta and San Luis Río Colorado stations, these have not operated continuously.⁹⁶
87. Mexico's air quality monitoring systems obey strict standards and quality control where data compilation and reporting is concerned. NOM-156-SEMARNAT-2012 (NOM-156) establishes the minimum conditions governing the establishment and operation of air quality monitoring systems. This standard issued by federal authorities applies to population centers and zones having any of the following characteristics:⁹⁸
- a) human settlements with population over 500,000;
 - b) metropolitan areas;
 - c) human settlements with air emissions in excess of 20,000 tons of primary criterion pollutants annually;
 - d) conurbations, and
 - e) industrial activities which, by virtue of their characteristics, require the establishment of air quality monitoring stations and air pollution sampling.
88. However, Caborca does not meet any of the criteria of NOM-156: its population is 81,309 (2010); it is not a metropolitan area, according to the indicators published by the National Population Council (*Consejo Nacional de Población*—Conapo);⁹⁹ and neither does it have any industrial activities that warrant air quality monitoring. As to the possibility that crop residue burning in Caborca results in a total volume of criterion air pollutants in excess of 20,000 tons, the Secretariat collected information indicating that the burning of asparagus crop residues does not exceed 20,000 tons/year (see table 7).
89. Both the measurement methods used to determine criterion pollutant concentrations and the criteria serving to determine ambient air quality are regulated by the Mexican Official Standards issued by Semarnat (in coordination with the Ministry of Health as applicable). The criterion pollutant standards are mandatory for federal and local authorities having responsibility for air quality monitoring and assessment, which must use the values and indicators set out in these standards as a reference.¹⁰⁰
90. The NOMs establishing the measurement methods and the calibration procedures for the equipment used to determine ambient concentrations of criterion pollutants—carbon monoxide (CO), total suspended particles (TSP), ozone (O₃), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂)—are, respectively, NOM-034-SEMARNAT-1993,¹⁰¹ NOM-035-SEMARNAT-1993,¹⁰² NOM-036-SEMARNAT-1996,¹⁰³ NOM-037-SEMARNAT-1993,¹⁰⁴ and NOM-038-SEMARNAT-1993.¹⁰⁵ The purpose of these standards is to establish the methods, techniques and standardized procedures for measuring and tracking the concentration of a substance or pollutant present in the air at a given place and time.
91. Similarly, Semarnat, in coordination with the Ministry of Health, has issued standards NOM-020-SSA-1993 to NOM-026-SSA1-1993, establishing criterion pollutant concentrations for ozone (O₃),¹⁰⁶ carbon monoxide (CO),¹⁰⁷ sulfur dioxide (SO₂),¹⁰⁸ nitrogen dioxide (NO₂),¹⁰⁹ total suspended particles (TSP),¹¹⁰ particles of less than 10 microns (PM₁₀),¹¹¹ particles of less than 2.5 microns (PM_{2.5}),¹¹² and lead (Pb).¹¹³ The purpose of these standards is to ensure that air quality is “satisfactory in all human settlements and regions of the country.”¹¹⁴

92. In summary, the municipality of Caborca regularly uses the templates contained in NOM-015 for aspects relating to fire control.¹¹⁵ However, the primary purpose of the standard is not the control of air pollution from crop residue burning, but control of these activities in forest areas. In addition, the municipal bylaw—REEMPA—would be subject to the legal framework for data compilation and reporting (NOM-156); the use of the standardized techniques and procedures applicable to the criterion pollutant which concentration is being measured, as per NOM-034 to NOM-038; and comparison of the results with the standards establishing permissible pollutant limits in NOM-020-SSA1 to NOM-026-SSA1. In other words, control and air quality measurement activities established in REEPMA have specific standards that one should consider in order to enforce the regulation.
93. Additionally, while the information obtained by the Secretariat relevant to the preparation of an air quality management program mentions the production of a diagnostic assessment,¹¹⁶ Caborca faces various obstacles in this regard because there are no guidelines for the development of air quality assessments available to the Municipal authorities. For example, in order to implement an assessment, it would be necessary to gather data from an air quality monitoring network following requirements pursuant to NOM-156, which—due to Caborca’s characteristics—is not applicable to this locality, and this would demand a sufficient budget and technical staff. Furthermore, a strategy would entail agreements with other government and civil society organizations.¹¹⁷

4.1 Emissions from asparagus crop residue burning in Caborca

94. Asparagus crop residue burning generates emissions that are dispersed as a function of climatic conditions, particularly temperature and wind speed. Figure 15 presents a satellite image of the dispersal of smoke presumed to originate from agricultural burning in the state of Sonora. It shows a plume near Caborca (Heroica Caborca on the figure) covering an area of nearly 10 km wide by 30 km long to the southeast.

Figure 15. Satellite image of dispersal of smoke presumed to originate from agricultural burning



Source: Produced by the Secretariat with data from the National Aeronautics and Space Administration (2013-2017), online at <<https://goo.gl/gsziry>> (viewed 8 January 2018).

95. To determine the emissions resulting from asparagus crop burning in Caborca, Sonora, the Secretariat conducted an exhaustive search of emissions inventories developed by various public institutions. Table 5 summarizes the inventories consulted by the Secretariat:

Table 5. Synopsis of emissions inventories for the state of Sonora

Identifier	Organization	Inventory	Base year	Coverage	Geographical resolution	Emissions	Items burned
INEM 2013	Semarnat	INEM	2013	National	Municipality of Caborca	CP	Sugarcane
ProAire Sonora 2014	Sonora State Government	ProAire Sonora	2014	State	Partially municipal	CP	No details
BECC 2015	BECC	GG emissions in Sonora	2015	State	State of Sonora	GG	Forage oats, barley, sweet and field corn, forage rye, and wheat
INEGEI 2013	INECC	INEGEI	2013	National	National	GG	114 crops, 99% of cultivated area
Sagarpa 2010	Sagarpa	Baseline*	2010	National	National	GG	Sugarcane

Source: BECC = Border Environment Cooperation Commission. INECC = National Institute of Ecology and Climate Change. INEM = Mexican National Emissions Inventory. INEGEI = National Greenhouse Gas Emissions Inventory. CP = criterion pollutants. GG = greenhouse gases.

*Baseline of the Natural Resources Sustainability Program.

96. The inventories listed in Table 5 consider criteria air pollutants and greenhouse gases from different types of crops. The difference in level of detail is more significant when comparing data at the national (INEGEI 2013 and Sagarpa 2010); State (BECC 2015) or municipal level (INEM 2013 and ProAire–Sonora 2014). However, some of the data reported in the inventories do not provide details on the type of source (i.e. low resolution). Nothing in the inventories indicates whether asparagus burning emissions were included or not. What is known however, is that the National Emissions Inventory (INEM 2013) report for Caborca, Son., specifically underestimates emissions (see paragraph 102). The only inventory allowing municipal-level comparisons for each emission source is INEM 2013.
97. To supplement the incomplete data provided for in the existing inventories, the CEC Secretariat conducted—with the support of Dr. Arturo Keer,¹¹⁸ a PhD in physics from *Universidad Nacional Autónoma de México* (UNAM) specialized in combustion and air pollutants monitoring an estimate based on the Intergovernmental Panel on Climate Change (IPCC) tier methodology for pollutant emissions. The IPCC Tier methodology takes into account the quantity of asparagus biomass burned per unit area and the total surface area devoted to asparagus farming (and burning) in hectares. The estimates calculated by Dr. Keer can be found in Appendix 6.
98. The burning of asparagus crop residues produces no net CO₂ emissions—according to the methodology used by the IPCC, there is no net accumulation of carbon in biomass—. However, biomass burning does generate other greenhouse gases and GHG precursors, such as carbon monoxide, methane, and nitrogen oxides, and volatile organic compounds other than methane.¹¹⁹

99. Pollutant emissions from asparagus burning can be obtained using the IPCC's Tier 1 (gain-loss) method. This method consists of multiplying an estimate of the quantity of biomass burned due to asparagus farming in a given area by an emission factor for each pollutant. The California Air Resources Board (CARB)¹²⁰ reports that the quantity of asparagus crop biomass burned is 3.36 t/hectare (metric ton per hectare). The results of the criterion pollutant and greenhouse gas emissions estimate are shown in Table 6. For the 2017 season, the asparagus crop in Caborca covered a cultivated (ergo burned) area of 10,171 ha, which translates into an estimated total of dry biomass of 34,200 metric tons per year which are then burned.¹²¹

Table 6. Emission factors used to estimate emissions from asparagus crop residue burning in Caborca

Inventory	Compound	Emission factor (g/kg)	Source
Greenhouse gases	CO ₂	1,515	[a]
	CH ₄	2.7	[a]
	N ₂ O	0.1	[a]
Criterion pollutants	PM ₁₀	20	[b]
	PM _{2.5}	19.7	[b]
	SO ₂	0.3	[b]
	CO	75	[b]
	NO _x	2.2	[b]
	VOC	33	[b]
	NH ₃	1.2	[b]

[a] H. Aalde et al., 2006 IPCC *Guidelines for National Greenhouse Gas Inventories*, vol. 4, *Agriculture, Forestry and Other Land Use*, ch. 2, "Generic Methodologies Applicable to Multiple Land-use Categories," Table 2.5, at 47.

[b] California Air Resources Board, *Smoke Emission Estimation: Agricultural Burning and Other Managed Burns*, "Managed Burn Emission Factor Table," online at <<https://goo.gl/W9LPaZ>> (viewed 5 December 2017).

100. Table 6 shows the emission factors used to estimate emissions of greenhouse gases (GHG) and criterion pollutants.
101. Table 7 presents the estimated emissions results calculated for asparagus crop residue burning in Caborca, Sonora, conducted by Dr. Keer, the expert that provided technical support to the Secretariat.
102. The INEM 2013 inventory—the only inventory for which data is available at the municipal level—considers emissions solely from sugarcane burning reported in Caborca. This results in a significant underestimation of emissions when compared with the estimates calculated by Dr. Keer once asparagus crop biomass burning is taken into account. The INEM 2013 inventory yields only 2 to 19% of the emissions when compared to asparagus crop residue burning, as may be seen in Table 8.
103. The emissions inventory included in ProAire–Sonora is of special relevance because its purpose is to provide a baseline from which to design pollutant emission control measures that can help improve air quality in urban areas of the state.¹²² However, the level of detail presented in the ProAire–Sonora document is insufficient to determine whether asparagus crop residue burning is included. The ProAire–Sonora does not state which crops were estimated for purposes of agricultural burning. In the ProAire–Sonora inventory, emissions from agricultural burning are 33% lower on average than those estimated in the national inventory (INEM 2013; see Table 9).

Table 7. Estimated emissions from asparagus crop residue burning in Caborca

Inventory	Compound	Emissions (Mg/year)	CO ₂ equivalent emissions (Mg CO ₂ -eq/year)
Greenhouse gases	CO ₂	51,813.8	*
	CH ₄	92.3	2,585.6
	N ₂ O	2.4	634.4
Criterion pollutants	PM ₁₀	684.0	
	PM _{2.5}	672.7	
	SO ₂	10.4	
	CO	2,565.0	4,617.1
	NO _x	76.8	
	VOC	1,128.6	
	NH ₃	40.5	
Total GG emissions (Mg CO ₂ -eq/year)			7,837.0

Source: Produced by the Secretariat based on: California Air Resources Board, *Smoke Emission Estimation: Agricultural Burning and Other Managed Burns*, "Managed Burn Emission Factor Table," online at <<https://goo.gl/W9LPaZ>> (viewed 5 December 2017).

*The burning of asparagus crop residues produces no net CO₂ emissions. The growing of the crop fixes carbon from the atmosphere which is then released when burned.

Table 8. Emissions from asparagus crop residue burning in Caborca, as per CEC 2017 and INEM 2013

Inventory	Compound	CEC 2017 ^[1] (Mg/year)	INEM 2013 ^[2] (Mg/year)	INEM 2013 ^[2] (Mg)
Greenhouse gases	CO ₂	51,813.8		Not available
	CH ₄	92.3	10.5	11%
	N ₂ O	2.4		Not available
Criterion pollutants	PM ₁₀	684.0	36.2	5%
	PM _{2.5}	672.7	34.4	5%
	SO ₂	10.4	2.0	19%
	CO	2,565.0	296.5	12%
	NO _x	76.8	11.7	15%
	VOC	1,128.6	23.1	2%
	NH ₃	40.5	5.9	15%

[1] Emissions from asparagus crop residue burning in Caborca, Sonora (calculated considering asparagus biomass).

[2] Emissions from crop residue burning in Caborca, Sonora (which considers sugarcane biomass).

Source: Produced by the Secretariat with data from INEM 2013.

Table 9. Agricultural burning emissions for Sonora and estimated emissions from asparagus crop residue burning in Caborca

Compound	CEC 2017 ^[1] (Mg/year)	INEM 2013 ^[2] (Mg/year)	ProAire Sonora 2014 ^[2] (Mg/year)	Ratio CEC 2017 and ProAire Sonora 2014
PM ₁₀	684.0	6,335.0	4,003.9	17%
PM _{2.5}	672.7	6,026.2	3,803.2	18%
SO ₂	10.4	388.5	283.3	4%
CO	2,565.0	61,291.5	41,742.0	6%
NO _x	76.8	2,237.9	1,504.2	5%
VOC	1,128.6	5,157.8	3,488.4	32%
NH ₃	40.5	1,226.7	835.4	5%
Average ratio:				12%

[1] Emissions from asparagus crop residue burning in Caborca, Sonora.

[2] Emissions from crop residue burning in Caborca, Sonora.

Source: Produced by the Secretariat with data from INEM 2013 and ProAire Sonora 2014.

104. As mentioned in paragraph 102, INEM 2013 underestimates the emissions from agricultural burning in the municipality of Caborca because it only considers sugarcane, which has a different biomass and percentage of crop subject to burning. Given the information available, it is possible that the ProAire–Sonora emissions were underestimated too. When comparing ProAire–Sonora agricultural burning state emissions data with Caborca’s asparagus burning emissions data calculated by the Secretariat’s expert (Dr. Keer), emissions from asparagus crop residue burning represent, on average, 12% of the crop residue burning emissions for the whole state (see Table 9 and Appendix 6).
105. The emissions inventory produced by the Border Environment Cooperation Commission (BECC) for Sonora is interesting in that it presents GHG emission projections until the year 2020. In contrast, the inventory generated by Sagarpa), intended to provide a baseline for the FAO-sponsored natural resources sustainability program, is relevant precisely because it served to establish the baseline for the agriculture sector greenhouse gas emissions indicator, thus yielding a starting point from which to analyze the impact of Sagarpa’s GHG emission reduction measures and concomitant climate change mitigation.
106. On another note, the INEGEI 2013 greenhouse gas emissions inventory produced by the National Institute on Environment and Climate Change (*Instituto Nacional de Ecología y Cambio Climático*—INECC) is the most up-to-date inventory: it is now more systematized and agricultural sector activity data is disaggregated. The emissions corresponding to crop residue burning are based on production data for 114 crops covering 99% of Mexico’s cultivated area. Such data are accessible through databases published by Sagarpa¹²³ which were applied by INECC according to a publication outlining the methodology.¹²⁴ However, when the database downloadable at the Sagarpa website was consulted, it did not produced data on asparagus. To provide an order of magnitude estimate, table 10 compares asparagus crop emissions in Caborca estimated by the Secretariat’s expert (CEC 2017) with respect to agricultural emissions in national (INEGEI 2013 and Sagarpa 2010) and state (BECC 2015) inventories.
107. As shown in Table 10 the values used for the baseline indicators established for GHG emissions reductions targets (140,028 mg CO₂ eq/year in Sagarpa 2010) are nearly ten times lower than the more up-to-date value (1,330,045 mg CO₂ eq in INEGEI 2013), which can be explained by the change of computational methodology. As regards the inventory from Sagarpa which, the emissions from asparagus crop residue

Table 10. GHG and precursor emissions (in Mg CO₂-eq/year) from agricultural burning as estimated in different inventories

Compound	Asparagus burning: Caborca	Crop residue burning: national	Crop residue burning: national	Crop residue burning: Sonora
	CEC 2017	INEGI 2013	Sagarpa 2010	BECC 2015
CH ₄	2,585.6	1,046,941.0	56,280.0	30,000.0
N ₂ O	634.4	283,104.0	7,950.0	
CO	4,617.1		75,798.0	
Total GHG emissions	7,837.0	1,330,045.0	140,028.0	30,000.0

Source: Produced by the Secretariat with data from the cited inventories.

burning in the municipality of Caborca alone account for 0.59% of the country's crop residue burning emissions, yet the area under asparagus cultivation in Caborca accounts for only 0.045% of the nation's total cultivated area.¹²⁵

4.2 Enforcement measures taken by the municipality of Caborca

108. The Secretariat requested information from the municipality of Caborca on the enforcement of REEPMA Articles 144, 146, and 172 as regards the incorporation of air pollution prevention and control criteria into the measures to control crop residue burning, the exercise of the relevant powers, and the establishment and operation of air quality monitoring systems.¹²⁶
109. With regard to the incorporation of criteria in REEPMA Articles 144, 146 et 172, the municipality indicated that on 28 April 2017, Profyh submitted a proposal to Sagarpa to conduct monitoring of contamination sources developed within the framework of the Agricultural Development Program, which grants economic incentives for the production of priority crops having market potential in zones with medium or high potential for their production.¹²⁷ The proposal was produced by the Universidad of Sonora and the air quality-related activities are as follows:¹²⁸
 1. To ascertain the level of environmental contamination caused by smoke and determine the degree of pollution from each source.
 - Activity:** Take samples of smoke arising from the burning of trash and agricultural products, as well as from vehicles in the Caborca region, and analyze the principal pollutants.
 - Goal:** Determine the levels of the principal pollutants.
110. The project submitted by Profyh proposes to sample nearly all pollution sources in the city of Caborca, including cattle and hog waste, wastewater, mining activities, dust, and solar radiation. The proposal establishes that each objective will be considered an independent research project and that a total of 312

weekly sampling events will take place each year. The proposal does not present further details about the methodology, such as reference standards, chain of custody, quality control, report production, peer review, etc. There is no itemization of the amount requested: the proposal simply states that “the total cost of the project is \$2,000,000.00 (one million five hundred thousand pesos M/N) [sic].”¹²⁹

111. Concerning efforts to implement an air quality monitoring system, the municipality of Caborca reported at the Working Meeting with the Secretariat that it would make contact with CEDES in order to request technical support for planning activities. In addition, the Director of Environmental Management of CEDES reported that the air quality monitoring equipment would be available for use by the municipality of Caborca.¹³⁰ On this, the Secretariat did not obtain further information on the status of specific actions.
112. According to information obtained by the Secretariat, ProAire–Sonora provides for the inclusion of the municipality of Caborca in the implementation of the program,¹³¹ and according to prior information, agricultural burning, trash burning, and pesticide use are perceived by the population as the main sources of pollution.¹³² Table 11 presents some of the agricultural burning control activities comprised by the ProAire–Sonora program for 2017 to 2026.
113. The actions and measures consist in the regulation of agricultural burning and the promotion of sustainable techniques for the use of the biomass resulting from the harvest; however, the responsibility for implementing this measure is assigned in the ProAire–Sonora, with a budget of three million pesos, to the municipalities of Cajeme and Navojoa only. There is no mention of the municipality of Caborca.¹³³
114. While ProAire–Sonora does provide for the promotion of best practices during agricultural burning,¹³⁴ the nature and scope of the document are such that it does not specify the activities that could be incorporated to avoid, decrease, or prevent emissions from crop residue burning. On the other hand, it proposes the implementation of air quality monitoring in cities that already possess the necessary equipment. In any event, there is an air quality contingency program for the state of Sonora, whose implementation is the responsibility of the Sonora State Environment Commission (*Comisión de Ecología del Estado de Sonora*—CEDES).¹³⁵

Table 11. Measures contained in ProAire–Sonora

Measure and description	Indicator	Timeline (year)									
		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Include regulation of agricultural burning in municipal bylaws	Bylaw updated										
Define sustainable techniques for biomass disposal or use	Techniques defined										
Define burning protocol	Annual burning protocol										
Training in sustainable biomass disposal and use techniques	Training courses										

Source: ProAire Sonora, at 124-5.

5. Measures taken by Mexico to effectively enforce REEPMA Article 167 with respect to the implementation of the measures necessary to prevent and control contingencies caused by air pollution

115. The Submitter asserts that REEPMA Article 167¹³⁶ gives the DDUE the power to take the measures necessary to prevent and control environmental contingencies caused by air pollution that may affect the population. The Submitter further contends that the failure to enforce these measures during the crop residue burning season causes air quality parameters to be exceeded “very frequently.”¹³⁷
116. As presented in section 2.1.2., REEPMA Article 167 provides as follows:
- Article 167.** The Municipal Council, acting by the [DDUE] and in coordination with the Municipal Civil Protection Unit, *shall take the measures necessary to prevent and control environmental contingencies caused by air pollution* for an area and/or for the whole population of the municipality where the air quality parameters established by the Mexican Official Standards are exceeded [emphasis added].
117. An initial consideration is that measures to prevent and control environmental contingencies are to be taken “where the air quality parameters ... are exceeded,” which presupposes that air pollution is being measured. Secondly, the term “environmental contingency” is defined in various instruments. Both LGEEPA Article 3 paragraph VIII and LEEPAS Article 3 paragraph XI define it as a “risk situation, arising from human activities or natural phenomena, that may endanger the integrity of one or more ecosystems.” A review of information on the various pollution control programs found that these have mechanisms for declaring an “environmental contingency.”¹³⁸
118. At the Working Meeting with the Secretariat, the municipality of Caborca reported that since there is no pollution monitoring system, the Municipal Council of Caborca can declare an environmental contingency when visibility is reduced by emissions from crop residue burning. It added that a contingency is declared when more than 400 hectares per day are burned. To date, the municipal authorities have no other objective parameter or system that would enable them to declare a contingency based on air pollution measurements. When a contingency is declared, crop residue burning is suspended. In response to a specific question from the Secretariat, the authorities specified that no other measures are taken to prevent risks affecting the population of Caborca.
119. The Controlled Burning Guidelines establish the general intent of the municipality of Caborca to conduct air quality monitoring. The text indicates that further to meetings held with Proaes, the Caborca Municipal Council, and Profyh with a view to reducing environmental contingencies, it was agreed to request technical support from Semarnat:
- That on 27 October 2016, further to the aforementioned agreement, [a] project designed by the Universidad de Sonora, Unidad Regional Norte to measure air quality in the municipality was submitted to the Sonora office of Semarnat with the goal of obtaining the monitoring systems necessary to measure air quality throughout the year.¹³⁹
120. The “project ... to measure air quality” submitted to Sagarpa is the one mentioned in section 4.2 above; no further information is available in regard to its status. Moreover, the reasons for which Sagarpa would authorize funding for the monitoring of contamination are altogether unclear.

6. Measures taken by Mexico to enforce REEPMA Articles 151 and 169 with respect to the permitting of crop residue burning and the prohibition on emitting pollutants in excess of the maximum permissible levels applicable to crop residue burning

6.1 Permitting

121. The Submitter asserts that no open-air burning permits have been issued and that the DDUE merely “report[s] the burning schedule.” The Submitter contends that this violates REEPMA Article 169, which provides that this activity requires a prior permit from the DDUE.¹⁴⁰
122. REEPMA Article 169 establishes the requirements for obtaining an open-air burning permit:

Article 169. To obtain the permit mentioned in the preceding article, the interested party shall apply to the Department in writing at least fifteen working days before the intended date of the event, with a copy to the competent agricultural authority and the municipal civil protection unit, fully justifying the necessity of the activity. The Department shall review the application and issue a decision within a period not to exceed fifteen working days, either unconditionally approving, conditionally approving, or denying the permit.
123. The Profyh representatives sent a copy of the form used to apply for a permit to use fire on forested or agricultural land pursuant to NOM-015-SEMARNAT/SAGARPA-2007. The form has spaces for producer information, proposed burning period, land type, burning method, and purpose, among other items. Appendix 4 contains a copy of the form used by Caborca growers. Once the application has been filed, the DDUE issues the corresponding permit, conditional on compliance with the allowed burning days and a schedule of 11:00 a.m. to 3:00 p.m.
124. The municipality did not inform the Secretariat as to the number of permits, number of growers and ratio of permits issued/denied. This coincides with a central assertion of the Submission: that the municipality lacks control over the application, procurement, monitoring, and enforcement of permits for agricultural burning.
125. According to information provided by Profyh at the Working Meeting with the Secretariat, the basis for fining growers is where they exceed the allowed area or perform burning outside of the established schedule. No other environmental parameters or measurements were mentioned as giving rise to violations.

6.2 Prohibition on activities exceeding maximum permissible limits

126. The Submitter asserts that REEPMA Article 151 prohibits open-air burning in cases where there is a possible impact on air quality, and therefore environmental instability, which allegedly occurs during crop residue burning.¹⁴¹
127. REEPMA Article 151 provides as follows:

Article 151. The open-air burning of urban solid waste is prohibited, as is that of the vegetation resulting from the clearing, felling, or removal of topsoil from any land, for the purposes of construction or for any other purpose. The municipality may only approve such burning where it does not create an environmental risk or impact on air quality and it is deemed by the competent authorities to be justified on applicable grounds. The controlled incineration of any waste, with the exception of waste deemed hazardous by the [LGEEPA] or other federal legislation, shall remain subject to the emissions provisions of the State Act.

128. REEPMA Article 151 establishes two requirements for approval of open-air burning of plant matter: i) that it “does not create an environmental risk or impact on air quality” and ii) that it is “deemed by the competent authorities to be justified on applicable grounds.”¹⁴²
129. According to the information in the November 2015 Minutes and the Controlled Burning Guidelines, as well as the information provided at the Working Meeting with the Secretariat, inspections to verify compliance with controlled burning activities are conducted by the staff of the Local Phytosanitary Committee. The agreement with the asparagus growers stipulates that they must grant access to the committee’s inspectors so that the latter can determine whether the growers are complying with the burning schedule and permitted area.
130. The municipality of Caborca authorities allow daily burning of a maximum of 3.5% of the total area under asparagus cultivation; for 2016-17 this represented 315 ha per day (of the total of 9,000 ha).¹⁴³ As per the municipality’s assertions, the limits are agreed upon at the start of the burning season and enforced through the burning permits. However, this is not shown by the corresponding documentation reflecting the REEPMA Article 151 requirements; namely, that the measure does not create a risk to the physical environment or create an impact on air quality, and that the measure is authorized for a justified reason.
131. Sapos and La Almita, both in the municipality of Caborca, were identified as the most critical areas, and for that reason the companies operating there (Las Tres Californias, Hortícola del Desierto, and Exportadora de Caborca) are not permitted to burn crop residues on the same day.¹⁴⁴
132. Agricultural burning is to take place between 11:00 a.m. and 3:00 p.m. It was decided not to change the schedule even when weather conditions might allow for the practice to continue after these hours.¹⁴⁵ Furthermore, unused burning hours may not be “banked” for use at a later time, nor may the concurrent burn area be increased on the grounds that no burning was conducted on previous days. The Secretariat found, for example, that in the Mexicali and Imperial Valleys, which are found in Baja California and California, “no-burn” days are declared as a function of weather conditions, commonly due to low inversion layers.¹⁴⁶
133. Growers have until November 30 of each year to submit their burning plans to the Local Phytosanitary Committee so as to allow inspections and coordinate the general burning plan and programs. The information provided to the Secretariat by the Municipal authorities for the development of this factual record was general and no details were given in terms of number of growers, area burned by each producer or recording for each burning activity on a daily basis.
134. In addition, growers pay the municipality \$30.00 (thirty pesos) per hectare burned per season.¹⁴⁷ The Municipal Council of Caborca assesses a fine of \$25.00 (twenty-five pesos) per hectare for non-compliance. The fines are assessed on the growers’ organization, Profyh. No more details were provided on the amounts effectively collected by the Municipality of Caborca.
135. According to the information provided, fines are assessed when crop residues are burned outside of the established schedule of 11:00 a.m. to 3:00 p.m. and/or when the total permitted area of 315 ha per day is exceeded. The municipality reported that a fine was assessed on one occasion but did not specify the date or the amount of the fine.¹⁴⁸



Photo: Courtesy of the Submitter.

7. Measures taken by Mexico to enforce REEPMA Article 170 in connection with alleged harm to public health occurred during open-air burning

136. The Submitter asserts that the population of the municipality suffers from adverse health effects persisting for “many days” during the crop residue burning season and that burning should be prohibited for this reason, in accordance with REEPMA Article 170.¹⁴⁹ The Submitter attributes these effects to the agrochemicals used during the planting period and also to violations of the provisions applicable to burning, since it takes place as a function of weather conditions in the municipality and not in accordance with the applicable legal provisions.¹⁵⁰
137. REEPMA Article 170 provides as follows:
- Article 170.** The Municipal Council shall not permit open-air burning where toxic pollutants are generated that may cause adverse health effects, harms, or nuisance in the exposed population, nor in the case of urban solid waste. Any permit that has been issued may be suspended, in whole or in part, and temporarily or permanently, where an extraordinary contingency event is caused by the burning, or where environmental and meteorological conditions do not allow for adequate dispersal of pollutants.
138. According to information from INECC, an assessment of the health impact of air pollutant emissions comprises four stages: identification of pollutants and health impacts; selection of exposure-response functions; assessment of exposure, and impact characterization.¹⁵¹
139. The selection of pollutants is directly related to the type of emission source, and the relative control measures are implemented in turn as a function of the pollutants studied. In this case, the pollutants are those related to crop residue burning. The smoke from biomass burning contains compounds including carbon monoxide (CO), hydrocarbons (HC), volatile organic compounds (VOC), benzene, polycyclic aromatic hydrocarbons (PAH), and particles under 2.5 microns (PM_{2.5}).¹⁵² It has additionally been found that agricultural burns are a source of dioxins, due to the presence of pesticide residues in the biomass.¹⁵³ Moreover, acute exposure to some of the pollutants emitted, such as PM_{2.5}, can have a harmful effect on human health. Various epidemiological studies have linked particulate exposure to higher mortality rates.¹⁵⁴
140. Concerning the health effects deriving from exposure to pollutants emitted during agricultural burning, table 12 summarizes the main impacts of short-term exposure as set out in the applicable Mexican reference standards:

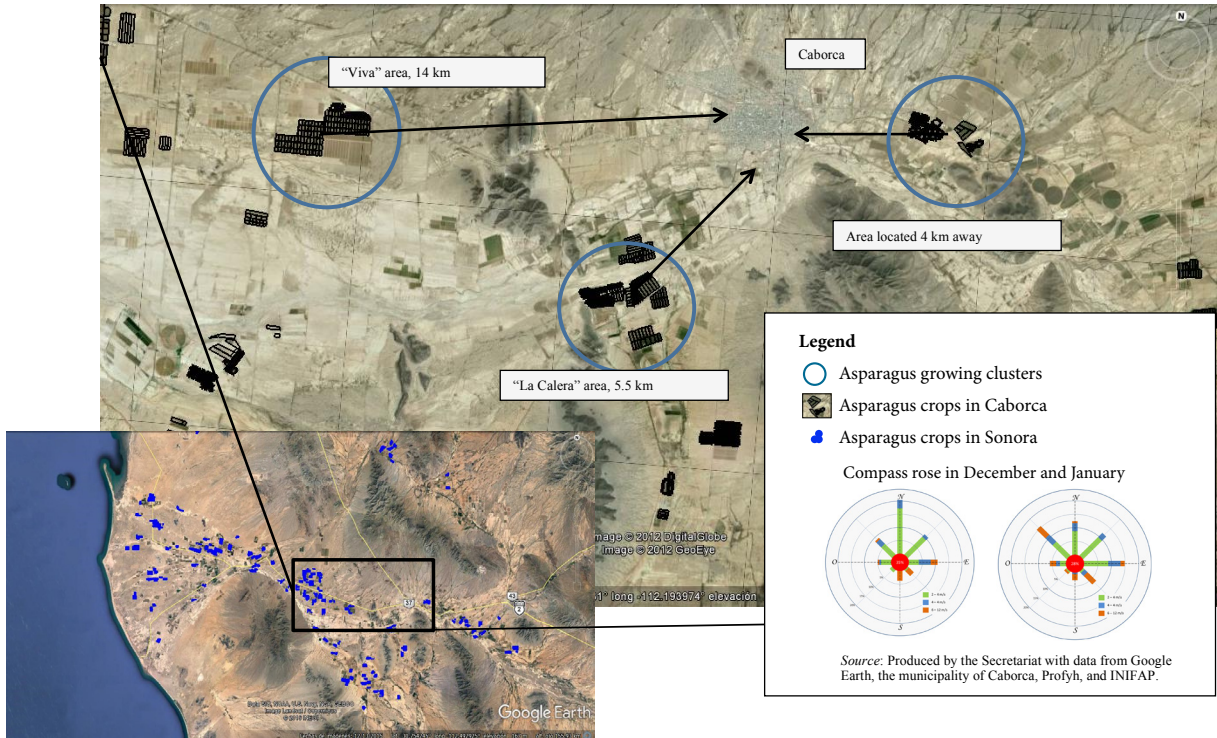
Table 12. Criterion pollutants, with WHO and NOM recommendations for human health protection

Pollutant	Short-term impacts	Long-term impacts	Concentration (time) and reference standard
Particles (PM ₁₀)	Mortality, hospital admissions due to respiratory and cardiovascular diseases	Infant and adult mortality due to cardiovascular and cardiopulmonary diseases, and adult mortality due to lung cancer	75 µg/m ³ (24 hours)
Particles (PM _{2.5})			40 µg/m ³ (annual arithmetic mean) (NOM-025-SSA1-2014)
Ozone (O ₃)	Mortality due to cardiovascular and respiratory diseases, reduced pulmonary function, exacerbation of asthma symptoms	Damage to pulmonary function and mortality due to respiratory disease	0.095 ppm (186.2 µg/m ³) (1 hour) 0.07 ppm (137.2 µg/m ³) (8 hours) (NOM-020-SSA1-2014)
Nitrogen dioxide (NO ₂)	Mortality due to cardiovascular and respiratory diseases, as well as general mortality and exacerbation of respiratory symptoms	Acts in synergy with particles, increasing the number of cases of mortality and morbidity	0.21 ppm/395 µg/m ³ (1 hour) (NOM-023-SSA1-1993)
Sulfur dioxide (SO ₂)	Hospital admissions due to respiratory and cardiovascular complications	Contributes to the formation of secondary particles responsible for cases of mortality and morbidity	0.11 ppm /288 µg/m ³ (24 hours) 0.025 ppm /66 µg/m ³ (annual arithmetic mean) 0.200 ppm/524 µg/m ³ (8 hours) (NOM-022-SSA1-2010)
Carbon monoxide (CO)	Exacerbation of heart disease and hospital admissions due to heart disease	Low birth weight among mothers exposed during pregnancy	11 ppm/12 595/µg/m ³ (8 hours) (NOM-021-SSA1-1993)

Source: Mexico, National Institute of Ecology (2011), *Guía para evaluar los impactos en la salud por la instrumentación de medidas de control de la contaminación atmosférica*, at 19, online at <<https://goo.gl/mYsxSz>> (viewed 27 November 2017).

141. Burning in the vicinity of Caborca is located at a distance of 3.5–25 kilometers from the city center, as shown in Figure 16.

Figure 16. Asparagus growing areas in the vicinity of Caborca



142. It is evident from the information gathered by the Secretariat that the average wind speeds are 3.2 and 3.6 m/s, respectively, for the months of December and January — i.e., the burning season — in Caborca. While the prevailing winds are from the east, north, northwest and northeast, and in general, low wind speeds in the region hinder the rapid dispersal of air pollutants. The burning closest to Caborca takes place approximately four kilometers west of the city (see photographs of the plume over Caborca on page 48). In the Mexicali and Imperial Valleys, under Baja California and California jurisdiction respectively, “special burning” permits have been issued for smoke-sensitive areas, such as rural schools, housing developments, buildings, etc., situated within a perimeter of 2.5 km.¹⁵⁵ In addition, emissions of PM_{10} and $PM_{2.5}$ caused by asparagus burning in Caborca are estimated by the Secretariat to be 684 and 672.7 ton/year, respectively, well above of those reported for Caborca in Semarnat’s National Emissions Inventory for base year 2013 (INEM 2013): 34.4 and 36.2 ton/year, respectively (see Table 8 *supra*). $PM_{2.5}$ and PM_{10} emissions are associated with a higher incidence of respiratory disease.



Photos: Courtesy of the Submitter

Crop residue burning in the vicinity of Caborca

143. In the November 2015 Minutes, the director of Public Health Jurisdiction No. 2 of the Ministry of Health stated:

[T]he Public Health Jurisdiction conducted an in-depth review to determine whether the smoke from asparagus burning has become a risk factor for diseases of the respiratory tract; it showed that no significant evidence for this was found, and that the low temperatures prevailing during this period are the main cause of respiratory tract conditions...

144. During the Working Meeting with the Secretariat, the director of this public health jurisdiction essentially reiterated what had been stated in the November 2015 Minutes; however, the only supporting information is a table of respiratory diseases and a table of mean temperatures recorded in Caborca. There is no further information available to corroborate the review conducted by the director of Public Health Jurisdiction No. 2, even though this information was requested by the Secretariat from the municipality of Caborca and the public health jurisdiction during the process of gathering information for the factual record. The requested information was never provided.

8. Ongoing commitment to transparency

145. Factual records provide detailed information regarding asserted failures to effectively enforce the environmental law in North America that may assist submitters, the NAAEC Parties, and other interested members of the public in following up on the matters addressed. This factual record draws no conclusions regarding what the Submitter alleges to be Mexico's failures to effectively enforce its environmental law, nor regarding the effectiveness of Mexico's enforcement efforts.
146. In accordance with NAAEC Article 15(3), this factual record is "without prejudice to any further steps that may be taken" with respect to Submission SEM-16-001 (*Agricultural Waste Burning in Sonora*).
147. In 2014, the CEC Council stated that the NAAEC Parties will provide yearly updated information on the actions they have taken in connection with submissions concluded in the previous year (including those for which a factual record was prepared).¹⁵⁶

Twenty years ago, North American leaders made a commitment that trade and economic growth would go hand-in-hand with effective trilateral cooperation and protection of the environment across the continent.

[...]

This year, we implemented a new reporting approach for submissions on enforcement matters (SEM) as part of our continued commitment to transparency and to the SEM modernization process. Following a proposal by the Joint Public Advisory Committee, each country provided an update on actions taken in connection with submissions concluded in the past year.

148. With a view to facilitating any follow-up that the public or the competent Mexican authorities may wish to perform, this factual record provides relevant information on the matters raised in the Submission and authorized by Council Resolution 17-03.

Notes

Except as otherwise indicated, all official documents cited herein are in the Secretariat's archives. Page references to the submission and the response in this factual record correspond to the original Spanish versions of these documents.

(Endnotes)

1. North American Agreement on Environmental Cooperation, published in the Official Gazette of the Federation (*Diario Oficial de la Federación*—DOF) on 21 December 1993.
2. Full details regarding the various stages of the process as well as previous Secretariat determinations and factual records can be found on the CEC's Submissions on Enforcement Matters page at <<http://www.cec.org/submissions>>.
3. SEM-16-001 (*Agricultural Waste Burning in Sonora*), NAAEC Article 14(1) Submission (22 January 2016), online at <<https://goo.gl/AkDdks>> [Original Submission].
4. Mexican Official Standard NOM-015-SEMARNAT/SAGARPA-2007, *Establishing the technical specifications for the use of fire on forested and agricultural land*, published in the DOF on 16 January 2009 [NOM-015].
5. *Guidelines for Submissions on Enforcement Matters under Articles 14 and 15 of the North American Agreement on Environmental Cooperation*, online at <www.cec.org/guidelines> (viewed 2 November 2015) [Guidelines].
6. SEM-16-001 (*Agricultural Waste Burning in Sonora*), Article 14(1) Determination (2 March 2016), online at <<https://goo.gl/8XabX9>> [Article 14(1) Determination].
7. SEM-16-001 (*Agricultural Waste Burning in Sonora*), NAAEC Article 14(1) Submission (29 April 2016), online at <<https://goo.gl/fjfSa>> [Revised Submission].
8. SEM-16-001 (*Agricultural Waste Burning in Sonora*), Article 14(1)(2) Determination (13 June 2016), online at <<https://goo.gl/K76NDd>> (viewed 5 December 2016).
9. SEM-16-001 (*Agricultural Waste Burning in Sonora*), Party Response (5 September 2016), online at <<https://goo.gl/BdFxD1>> [Response].
10. SEM-16-001 (*Agricultural Waste Burning in Sonora*), Article 15(1) Notification (27 February 2017), online at <<https://goo.gl/UXC8YM>> [Notification].
11. SEM-17-003 (*Agricultural Waste Burning in Sonora*) and Council Resolution 17-03 (9 June 2017), online at <<https://goo.gl/nmUstr1>> [Council Resolution].
12. CEC Secretariat, doc. no. A14/SEM/16-001/73/REQ (20 July 2017).
13. On this aspect, see R. Brañes (2000), *Manual de derecho ambiental mexicano*, Fundación Mexicana para la Educación Ambiental, Fondo de Cultura Económica, Mexico, at 90-6.
14. Passed in 1988, LGEEPA defines the framework environmental law in Mexico.
15. See Appendix 3 of this factual record for the text of these provisions.
16. LGEEPA Articles 7 paragraph XXII and 8 paragraph XVII:
Article 7. The States, pursuant to the provisions of this Act and the applicable local laws, have the following powers:...
XXII. To exercise any other powers not expressly reserved to the Federation that are vested in them by this Act, or by other ordinances in conformity with it, and that relate to the preservation of ecological stability and the protection of the environment;
Article 8. The Municipalities, pursuant to the provisions of this Act and the applicable local laws, have the following powers:...
XVII. To exercise any other powers not expressly reserved to the Federation or the states that are vested in them by this Act, or by other ordinances in conformity with it, and that relate to the preservation of ecological stability and the protection of the environment;

17. Mexican Constitution, Article 115, paragraph III(i), emphasis added.
18. Concerning concurrent powers held by the federation, the states, and the municipalities, LGEEPA Article 1 paragraph VIII provides that its provisions:

Article 1.... are matters of public order and the societal interest, and their purpose is to promote sustainable development and establish the basis for:...

VIII. The exercise of the environment-related powers vested in the Federation, the states, the Federal District, and the municipalities, according to the principle of concurrence set out in Article 73 paragraph XXIX-G of the Constitution;
19. LGEEPA Article 5 paragraph XII:

Article 5. The following are powers of the Federation:...

XII. The regulation of air pollution from all types of emission sources, as well as prevention and control in zones or in the case of fixed and mobile sources under federal jurisdiction;...
20. LGEEPA Article 9 refers to the environmental powers of Mexico City.
21. LGEEPA Article 112 paragraph I, emphasis added.
22. RPCAA Article 4 paragraph III, emphasis added.
23. Official Gazette of the State of Sonora, vol. CXCVIII, no. 14, section II, 17 February 2014, Hermosillo, Sonora.
24. Mayorality Office (*Presidencia Municipal*) of Caborca, *Minutes of the working meeting to establish the ordinance regulating the controlled burning of asparagus in the Caborca region, 2015-16 season*, November 2015 [November 2015 Minutes].
25. *Guidelines establishing the ordinance regulating and authorizing the controlled burning of asparagus in the Caborca region, 2016-17 season* (29 December 2016), signed by the municipality of Caborca, Public Health Jurisdiction No. 2 of the Sonora State Ministry of Health, the Director of Rural Development of Sagarpa, the Local Phytosanitary Committee, a representative of INIFAP, and Profyh.
26. November 2015 Minutes.
27. The Working Meeting with the Secretariat was attended by representatives of the municipality of Caborca (the mayor, the secretary general of the Municipal Council, and representatives of the Department of Urban Development and Public Works and the Environment Department); representatives of Profyh accompanied by their advisors, and asparagus growers who are members of this organization. Also in attendance were representatives of the Sonora State Ministry of Government; the Sonora State Attorney for Environmental Protection (*Procuraduría Ambiental del Estado de Sonora—Proaes*), Public Health Jurisdiction No. 2 of the Sonora State Ministry of Health (*Secretaría de Salud del Estado de Sonora*), and the Local Phytosanitary Committee (*Junta Local de Sanidad Vegetal*) of Caborca.
28. Response at 12.
29. *Ibid.* at 13.
30. *Ibid.*
31. *Ibid.*
32. INIFAP, “Laboratorio Nacional de Modelaje y Sensores Remotos, Estado de Sonora, Estación Canutillo,” online at <<https://goo.gl/o2RtNF>> (viewed 30 November 2017). The means were calculated for the months of December 2006, 2007, 2009, 2010, and 2011, and for the months of January 2007, 2008, 2009, 2010, and 2011.
33. Sedesol (2014), *Informe anual sobre la situación de pobreza y rezago social*, online at <<https://goo.gl/Mk39DM>> (viewed 21 November 2017).
34. Older adults have a higher risk due to weakening of the heart, lungs, and immune system. Babies and children are more vulnerable to air pollution due to their less-developed respiratory and immune systems and because they inhale more air as a percentage of body weight. See Environment Canada and Health Canada, *The Air Quality Health Index: Frequently Asked Questions*, online at <<https://goo.gl/CMNFMB>> (viewed 21 November 2017).
35. For more information about the concept and scope of “populations vulnerable to air pollution,” see N. Stilianakis (2015), “Susceptibility and vulnerability to health effects of air pollution: The case of nitrogen dioxide,” *JRC Technical Reports*,

- European Union, online at <<https://goo.gl/kvy1Cf>> (viewed 21 November 2017); H. Riojas Rodríguez *et al.* (2009), *Efecto de la temperatura y su interacción con el ozono sobre las admisiones hospitalarias en la Ciudad de México de 1998 al 2007: grupos poblacionales vulnerables*, Centro Virtual de Cambio Climático, Mexico, online at <<https://goo.gl/b32sQB>> (viewed 21 November 2017); Metropolitan Environment Commission (*Comisión Ambiental Metropolitana*), *Programa para mejorar la calidad del aire de la Zona Metropolitana del Valle de México 2011-2020*, online at <<https://goo.gl/N4Bmb4>> (viewed 21 November 2017).
36. Sagarpa (2017), “Se triplica producción de espárragos en México en sólo una década,” press release, Ministry of Agriculture, Livestock Production, Rural Development, Fisheries, and Food, Mexico, online at <<https://goo.gl/uaKtQ3>> (viewed 23 November 2017).
37. M. Bellemare (2013), *What Causes the Price of Food to Rise?*, Best Food Facts, 2 de agosto, disponible en: <<https://goo.gl/EdiYg2>> (consulta realizada el 5 de diciembre de 2017). Véase también: A. Tong (2012), “Factors Influencing Price of Agricultural Products and Stability Countermeasures”, *Asian Agricultural Research*, núm. 4, vol. 4, pp. 17-19, disponible en: <<https://goo.gl/TTjXZL>> (consulta realizada el 5 de diciembre de 2017).
38. *Ibid.*
39. Sagarpa (2015), *Agenda técnica agrícola de Sonora*, 2nd ed., Mexico, at 121-3.
40. *Agenda técnica agrícola de Sonora* was published in 2015; the cited figure probably refers to 2010, since the area under cultivation in 2011 was over 9,400 hectares and it continued to increase, reaching 14,762 hectares in 2017 according to OIAPES data: *Información del sector agrícola, pesquero y acuícola del estado de Sonora*, online at <<https://goo.gl/bvNp7h>>. The data was downloaded by selecting “Agricultura,” “Producción agrícola,” “Serie Histórica por Cultivo de Perennes,” and then “Espárrago” under “Cultivos” (viewed 23 November 2017).
41. Some sources cite Sonora as the leading Mexican producer of up to ten crops: see Sagarhpa-Sonora, Agriculture Branch (2016), *Programa de Mediano Plazo Agrícola 2016-2021*, June, at 1, online at <<https://goo.gl/ML4hkC>> (viewed 23 November 2017) [Medium-term Agricultural Plan].
42. *Ibid.* at 9.
43. Article 3 paragraph XXXII of the Sustainable Rural Development Act (*Ley de Desarrollo Rural Sustentable*) defines a product system (*sistema-producto*) as:
 The set of concurrent factors and agents of the production processes for agricultural products, including supply of technical equipment, inputs, financial resources, primary production, storage, processing, distribution, and marketing.
 On this same concept, see Cuevas Reyes *et al.* (2011), “El concepto de sistema producto como eje de las políticas agropecuarias en México: Análisis del medio rural latinoamericano,” at 83-93:
 Product systems in Mexico operate through regional committees made up of growers, processors, marketers, service providers, government agencies, etc., which are tasked with identifying and performing those activities that can render the supply chain more efficient and profitable. An indispensable tool for this purpose is a master plan identifying short-, medium-, and long-term measures and/or projects. However, the master plan is only one of the elements needed to consolidate the integration and regionalization of product system chains. The major challenge is to ensure the existence of enterprising leadership on the part of the participants in the production chain and the regional product systems committees, so as to provide for continuity in the implementation of the necessary measures and projects.
44. In this regard, “the economic interests at stake are too large for decision-making to be shared with another organization”: Medium-term Agricultural Plan, at 17.
45. OIAPES, online at <<https://goo.gl/nmEsYh>> (viewed on 22 November 2017).
46. T. Karst, Asparagus market drops after spike, *The Packer*, 11 October 2017, at: <<https://goo.gl/WFodUr>> (viewed on 27 November 2017)
47. CIAD, “El espárrago, orgullo de Sonora y del CIAD, notas, Centro de Investigación en Alimentación y Desarrollo, A.C. (2016), online at <<https://goo.gl/ErM4Ey>> (viewed on 27 August 2018) [CIAD, 2016].

48. B. Aegerter *et al.* (2011), *Asparagus Production in California*, The Regents of the University of California Agriculture and Natural Resources, Vegetable Research & Information Center, at 1 [Aegerter *et al.* (2011)].
49. V.A. Fritz *et al.* (2013), *Asparagus production guide*, University of Minnesota Extension, online at <<https://goo.gl/xGiYjH>> (viewed 2 August 2018) [Fritz *et al.*].
50. For an estimate of production costs in different regions of the United States, see, e.g., J.S. Neibergs and T. Waters, *Estimated costs and returns for establishing and producing asparagus in Washington in 2009*, Washington State University Extension, online at <<https://goo.gl/1qW5fx>> (viewed 5 December 2017), or B. Aegerter *et al.* (2013), *Sample costs to establish and produce asparagus*, University of California Cooperative Extension, online at <<https://goo.gl/dzHXCp>> (viewed 5 December 2017).
51. Aegerter *et al.*, 2011, *op. cit.*
52. The Secretariat confirmed this information through interviews with asparagus growers in California, Quebec and Peru.
53. Querétaro State Ministry of Agricultural Development (*Secretaría de Desarrollo Agropecuario*), “Requerimientos agroecológicos de cultivos,” entry for asparagus, online at <<https://goo.gl/u2w4zT>> (viewed 5 December 2017). See also: J.A. Ruiz Corral *et al.* (2013), *Requerimientos agroecológicos de cultivos*, Technical Handbook no. 3, INIFAP, Campo Experimental Centro Altos de Jalisco, Tepatitlán de Morelos, Jalisco, Mexico, 2nd ed., at 198.
54. *Ibid.*
55. Fritz *et al.*, *op. cit.*
56. M. de J. Valenzuela Ruiz, F. Robles Contreras, R. Macías Duarte, and R.L. Grijalva Contreras (2015), “Efecto de la quema del follaje del espárrago en la época de cosecha y rendimiento, en la región de Caborca,” *Memorias del XVIII Congreso Internacional en Ciencias Agrícolas*, Mexicali, Baja California, Mexico [M. de J. Valenzuela Ruiz *et al.* (2015)].
57. INIFAP (2010), *Guía técnica para el área de influencia del campo experimental Costa de Hermosillo*, Table 38, December, at 127, Centro de Investigación Regional del Noreste, Campo Experimental Costa de Hermosillo, Sonora, Mexico, online at <<https://goo.gl/2HFMdE>> (viewed 5 December 2017).
58. M.A. Zamora Camarillo (1999), *Principales plagas y enfermedades en el cultivo del espárrago* (*Asparagus officinalis* L.), thesis, Universidad Autónoma Agraria Antonio Narro, Agronomy Division, Department of Parasitology, at 18-19.
59. Marketing and Agricultural Markets Agency (*Agencia de Servicios a la Comercialización y Desarrollo de Mercados Agropecuarios—Aserca*) (1996), *Claridades Agropecuarias*, no. 32.
60. C. Navarro Ainsa (2002), *Tecnología para el manejo del espárrago en el noroeste de Sonora*, Centro de Investigación Regional del Noroeste, Campo Experimental Región de Caborca, INIFAP, at 8, online at <<https://goo.gl/UeJ4tC>> (viewed 6 December 2017).
61. University of Minnesota Extension, “Asparagus Production Guide: Harvest,” online at <<https://goo.gl/AJDD4y>> (viewed 27 November 2017).
62. See, e.g., *Harlander Landtechnik GmbH*, online at <<https://goo.gl/s8J7Xs>> (viewed 27 November 2017), and *Tehmos*, online at <<https://goo.gl/iYZgc9>> (viewed 27 November 2017).
63. University of Delaware, College of Agriculture and Natural Resources (2016-2017), *2016 Mid-Atlantic Commercial Vegetable Production Recommendations*, Section F, “Asparagus,” online at <<https://goo.gl/GpFM2S>> (viewed 24 October 2017).
64. Meeting of 28 September 2017 in Caborca, Son., with Caborca representatives, Profyh representatives, and asparagus growers, among others [Working Meeting with the Secretariat].
65. M. de J. Valenzuela Ruiz *et al.* (2015), *op. cit.*
66. *Ibid.* The annual per-hectare yield is 580 30-lb boxes without burning or 612 with burning.
67. See November 2015 Minutes. Concerning the assertion about burning, the comment, by Fabián Robles Contreras, was ratified by the growers at the Working Meeting with the Secretariat. Asparagus plants come out of dormancy and edible spears form when soil temperature exceeds 10 °C; see, e.g., Aegerter *et al.* (2011), at 1. On early harvesting of asparagus, see M. de J. Valenzuela Ruiz *et al.* (2015), *op. cit.*

68. F. Schäfer *et al.*, “Comparison of CO₂e emissions associated with regional, heated and imported asparagus,” *Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector*, California, 2014. P. Dalampakis *et al.* (2017), “Technical and economic assessment of geothermal soil heating systems in row covered protected crops: A case study from Greece,” *Applied Energy*, vol. 203, at 201-18. A. Heißner *et al.* (2006), “Spear yield and quality of white asparagus as affected by soil temperature,” *European Journal of Agronomy*, vol. 25, no. 4, at 336-44.
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70. C. Navarro Ainsa (2002), *op. cit.*, at 23, and M. de J. Valenzuela Ruiz *et al.* (2015), *op. cit.*, at 929.
71. Government of Mexico, Contacto PyME, Business Cluster Program (*Programa de Agrupamientos Empresariales*), Diagnostic assessment of industrial clusters in the food and beverage sector, state of Sonora: Fruits and vegetables, Strategic Group on Asparagus, Mexico, at V-11, online at <<https://goo.gl/6GBiPg>> (viewed 6 December 2017).
72. Centro de Investigación Regional del Noreste (2010), *Guía técnica para el área de influencia del campo experimental Costa de Hermosillo*, December, at 128, 215.
73. SIAP, “Estadística de Producción Agrícola 2016”, open data Servicio de Información Agroalimentaria y Pesquera, en: <<https://goo.gl/jKgXLh>> (viewed on 2 August 2018)..
74. Environmental Protection Bylaw (*Reglamento de Protección y Preservación al Ambiente*) for the Municipality of San Luis de la Paz, Guanajuato, published in the Official Gazette of the Guanajuato State Government (7 December 2012), no. 196, vol. CL, year XCIX, at 58:
Article 96. The large-scale open-air burning of any type of material, solid or liquid waste, including household waste, leaves, dry or green grass, agricultural crops, tires, plastics, and/or other items; as well as burning for purposes of clearing grazing or agricultural land, are prohibited, except where such burning is used to train firefighting personnel as prescribed by the applicable legal provisions.
75. ARS section 49-501.
76. SDCAPCD Rule 101.
77. ICAPCD Rule 701.
78. G. Millan (2014), *Propagación in vitro de espárrago (Asparagus officinalis L.) por organogénesis directa a partir de yemas del rizoma*, M.Sc. thesis, Centro de Investigación en Alimentación y Desarrollo, A.C., Hermosillo, Son., Mexico, at 3.
79. R.A. Boydston (1988), “Seedling volunteer asparagus, *Asparagus officinalis*: Control with herbicides,” *Weed Technology*, vol. 2, no. 3, July, at 294-8.
80. D. Hemphill, *Oregon Vegetables: Asparagus*, Oregon State University, College of Agricultural Sciences, Department of Horticulture, online at <<https://goo.gl/P15WJJ>> (viewed 6 December 2017).
81. List of approved pesticides provided by legal representatives of Profyh in archives of the Secretariat.
82. Commission for Environmental Cooperation (2014), *Burning Agricultural Waste: A Source of Dioxins*, Montreal, Canada, at 4 online at <<https://goo.gl/k7cxGV>>.
83. S. Carreón (2014), *Experiencia en la producción de espárrago en Misión del Bisani*, report of work experience, Cuautitlán Graduate Faculty, Universidad Nacional Autónoma de México, at 60-1.
84. UNEP (2005), *Programa Interinstitucional para el Manejo Adecuado de los Productos Químicos: emisiones de dioxinas y furanos por quema incontrolada de biomasa*, December, at 4, online at <<https://goo.gl/tyiHCz>> (viewed 6 December 2017).
85. Revised Submission, at 1.
86. Semarnat, *Estrategia Nacional de Calidad del Aire 2017-2030*, Mexico, at 64.
87. NOM-156-SEMARNAT-2012, *Establishment and operation of air quality monitoring systems*.

88. Semarnat (2013), *Calidad del aire: Una práctica de vida*, Mexico, at 17.
89. ProAireSonora, at xii.
90. Semarnat (2013), *Calidad del aire: Una práctica de vida*, *op. cit.*, at 20.
91. Government of the Federal District, Ministry of the Environment (2006), *La calidad del aire en la Zona Metropolitana del Valle de México: 20 años de monitoreo atmosférico*, Mexico, at 7.
92. *Ibid.* at 4.
93. Semarnat (2017), *Programas de Gestión para Mejorar la Calidad del Aire (ProAire)*, online at <<https://goo.gl/1r6tF6>> (viewed 21 November 2017).
94. Semarnat, *Programa de Gestión para Mejorar la Calidad del Aire en el Municipio de Nogales, Sonora, 2016*, online at <<https://goo.gl/2fMwhn>> (viewed 21 November 2017).
95. These municipalities are Agua Prieta, Cananea, Cumpas, Guaymas, Hermosillo, Naco, Nacozari, Navojoa, Nogales, Puerto Peñasco, and San Luis Río Colorado; ProAire–Sonora, at 28-30.
96. ProAire–Sonora, at 31.
97. NOM-156-SEMARNAT-2012, *Establishment and operation of air quality monitoring systems*.
98. *Ibid.*, paragraph 2.0, “Scope of Application.”
99. Conapo, *Delimitación de zonas metropolitanas en México* (2010), online at <<https://goo.gl/Htv6nn>> (viewed 11 December 2017); Conapo, “Glosario,” online at <<https://goo.gl/LrkJ2x>> (viewed 11 December 2017).
100. Mexican Official Standard NOM-025-SSA1-2014, *Environmental health. Maximum permissible values for the concentration of PM₁₀ and PM_{2.5} suspended particles in ambient air and criteria for their assessment*, published in the DOF on 20 August 2014, online at <<https://goo.gl/JZKm5h>> (viewed on 20 November 2017).
101. Mexican Official Standard NOM-034-SEMARNAT-1993, *Establishing the measurement methods for determination of the carbon monoxide concentration in ambient air and the calibration procedures for measurement equipment*, published in the DOF on 18 October 1993, online at <<http://sinaica.inecc.gob.mx/pags/nomsMed.php>> (viewed 20 November 2017).
102. Mexican Official Standard NOM-035-SEMARNAT-1993, *Establishing the measurement methods for determination of the total suspended particle concentration in ambient air and the calibration procedure for measurement equipment*, published in the DOF on 18 October 1993, online at <<http://sinaica.inecc.gob.mx/pags/nomsMed.php>> (viewed 20 November 2017).
103. Mexican Official Standard NOM-036-SEMARNAT-1993, *Establishing the measurement methods for determination of the ozone concentration in ambient air and the calibration procedures for measurement equipment*, published in the DOF on 18 October 1993, online at <<http://sinaica.inecc.gob.mx/pags/nomsMed.php>> (viewed 20 November 2017).
104. Mexican Official Standard NOM-037-SEMARNAT-1993, *Establishing the measurement methods for determination of the nitrogen dioxide concentration in ambient air and the calibration procedures for measurement equipment*, published in the DOF on 18 October 1993, online at <<http://sinaica.inecc.gob.mx/pags/nomsMed.php>> (viewed 20 November 2017).
105. Mexican Official Standard NOM-038-SEMARNAT-1993, *Establishing the measurement methods for determination of the sulfur dioxide concentration in ambient air and the calibration procedures for measurement equipment*, published in the DOF on 18 October 1993, online at <<http://sinaica.inecc.gob.mx/pags/nomsMed.php>> (viewed 20 November 2017).
106. Mexican Official Standard NOM-020-SSA1-1993, *Environmental health. Criterion for assessment of the maximum permissible values for the ozone (O₃) concentration in ambient air. Air quality assessment criterion*, published in the DOF on 30 October 2002, online at <<http://goo.gl/9kTTHx>> (viewed 20 November 2017).
107. Mexican Official Standard NOM-021-SSA1-1993, *Environmental health. Criterion for ambient air quality assessment with respect to carbon monoxide (CO). Permissible value for the carbon monoxide concentration in ambient air as a public health protection measure*, published in the DOF on 23 December 1994, online at <<http://goo.gl/KGWWCt>> (viewed 20 November 2017).

108. Mexican Official Standard NOM-022-SSA1-2010, *Environmental health. Criterion for ambient air quality assessment with respect to sulfur dioxide (SO₂)*. Standard value for sulfur dioxide (SO₂) concentration in ambient air as a public health protection measure, published in the DOF on 8 September 2010, replacing NOM-022-SSA1-1993, published 8 December 1994. Online at <<http://goo.gl/SlgmXo>> (viewed 20 November 2017).
109. Mexican Official Standard NOM-023-SSA1-1993, *Environmental health. Criterion for ambient air quality assessment with respect to nitrogen dioxide (NO₂)*. Standard value for the nitrogen dioxide (NO₂) concentration in ambient air as a public health protection measure, published in the DOF on 23 December 1994, online at <<http://goo.gl/BcetLq>> (viewed 20 November 2014).
110. Mexican Official Standard NOM-025-SSA1-1993, *Environmental health. Criteria for assessment of the maximum permissible value for the concentration of particulates. Maximum permissible value for the concentration of total suspended particles (TSP), particles under 10 microns (PM₁₀), and particles under 2.5 microns (PM_{2.5}) in ambient air. Air quality assessment criteria*, published in the DOF on 26 September 2005, online at <<http://goo.gl/Wa1ogU>> (viewed 20 November 2017).
111. *Ibid.*
112. *Ibid.*
113. Mexican Official Standard NOM-026-SSA1-1993, *Environmental Health. Criterion for ambient air quality assessment with respect to lead (Pb)*. Standard value for the concentration of lead (Pb) in ambient air as a public health protection measure, published in the DOF on 23 December 1994.
114. See, e.g., the introduction to NOM-023-SSA1-1993, online at <<http://goo.gl/BcetLq>> (viewed 20 November 2017).
115. *Cfr.* REEPMA, Artículo 168 which establishes that open-air burning activities are allowed through a permit applied through the forms and following the requirements established in NOM-015.
116. Semarnat (2015), *Guía para la elaboración de programas de gestión para mejorar la calidad del aire (ProAire)*, Mexico, at 8.
117. *Ibid.*
118. Arturo Keer is a graduate of the career in Physics of the National Autonomous University of Mexico; he obtained a Master of Science in Combustion and Pollution Control, and a PhD specializing in simulation of burners by Computational Fluid Dynamics at the University of Sheffield, England. Dr. Keer worked for the University of Sheffield, developing mathematical models for simulating high-temperature processes and was a professor of postgraduate studies at the Research Center for Advanced Materials, SC, Chihuahua, Mexico, where he was also in charge of Fuel Cell Laboratory and later became Chief of the Division of Environment. Dr. Keer has participated as an assistant to environmental auditor at various Pemex facilities, and has been a consultant in environmental matters since 2005, participating in the development of national emissions inventories in Mexico and carrying out various projects on environmental issues.
119. H. Aalde *et al.*, 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, vol. 4, *Agriculture, Forestry and Other Land Use*, ch. 2, “Generic Methodologies Applicable to Multiple Land-use Categories,” at 47.
120. California Air Resources Board, *Smoke Emission Estimation: Agricultural Burning and Other Managed Burns*, “Managed Burn Emission Factor Table,” Excel table: [mngdburnemissionfactors.xls](https://goo.gl/9XsS3y), online at <<https://goo.gl/9XsS3y>> (viewed 27 November 2017). In the spreadsheet, the quantity of biomass actually burned is the fuel load.
121. Sagarhpa-Sonora, OIAPES, *Información agropecuaria, pesquera y acuícola del estado de Sonora*, “Cultivos perennes, año 2017: espárrago,” online at <<https://goo.gl/CSosZS>> (viewed 27 November 2017).
122. ProAire–Sonora, p. 47.
123. Sagarpa, *Sistema de Información Agroalimentaria de Consulta*, database downloadable at: <<https://goo.gl/N6yoKq>> (viewed on 27 February 2018).
124. INECC, *Inventario de Gases y Compuestos de Efecto Invernadero-actualización 2013*, presentation, p. 13.
125. According to Sagarpa’s Third Progress Report for 2014-2015, the cultivable area of the country amounted to 22.1 million hectares.
126. CEC Secretariat, doc. no. A14/SEM/16-001/73/REQ (20 July 2017).
127. Sagarpa, Agro-Technological Research, Innovation, and Development Program, online at <<https://goo.gl/H53pZn>> (viewed 30 November 2017).

128. R. Hernández León *et al.* (2017), “Contaminación ambiental ocasionada por los principales afluentes de contribución, en la ciudad de Caborca, Sonora, México,” proposal submitted by Profyh to Sagarpa.
129. *Ibid.*
130. Working meeting with the Director of Environmental Management, Héctor Lizárraga Hernández, 27 September 2017, in the city of Hermosillo, Sonora.
131. ProAire–Sonora, at 17.
132. *Ibid.* at 97.
133. *Ibid.* at 124.
134. ProAire–Sonora, measure 9.
135. ProAire–Sonora, measure 11.
136. See REEPMA Article 167.
137. Revised Submission, at 1.
138. Cofepris, Air Pollution Contingencies Program (*Programa para Contingencias Ambientales Atmosféricas*), online at <<https://goo.gl/m89B1m>> (viewed 5 December 2017).
139. Controlled Burning Guidelines, at 1.
140. Revised Submission, at 1-2.
141. Revised Submission, at 1.
142. See REEPMA Article 151.
143. *Controlled Burning Guidelines*, at 1.
144. *Ibid.* at 2.
145. *Ibid.*
146. M. Quintero and A. Moncada (2008), “Contaminación y control de las quemas agrícolas en Imperial, California, y Mexicali, Baja California,” *Región y Sociedad*, vol. 20, no. 43, Hermosillo, Son., Mexico, online at <<https://goo.gl/7QVCA9>> (viewed 1 December 2017) [Quintero and Moncada (2008)].
147. November 2015 Minutes, at 2.
148. Working Meeting with the Secretariat.
149. Revised Submission, at 2: “many residents complain of burning eyes and throat, headaches, and so forth, lasting for many days during the burning season.”
150. *Ibid.*
151. National Institute of Ecology (2011), *Guía para evaluar los impactos en la salud por la instrumentación de medidas de control de la contaminación atmosférica*, Mexico, at 11, online at <<https://goo.gl/cgHfm1>> (viewed 27 November 2017).
152. B. Jenkins, D. Jones, S. Turn, and R. Williams (1996), “Emission Factors for Polycyclic Hydrocarbons from Biomass Burning,” *Environmental Science and Technology*, vol. 8, no. 30, at 2462-9, cited in L. Sally Liu (2005), *Exposure and Health Assessments of the Effects of Agricultural Burning in Young Adults with Asthma Living in Pullman, Washington*, Washington State Department of Ecology, Final Report, April 6.
153. CEC (2014), *Burning Agricultural Waste: A Source of Dioxins*, *op. cit.*, at 2.
154. *Ibid.*
155. Quintero and Moncada (2008), *op. cit.*
156. CEC (2014), *CEC Ministerial Statement – 2014*, Twenty-first Regular Session of the CEC Council, Yellowknife, Northwest Territories, Canada (17 July 2014), online at <<http://goo.gl/u5TqsN>>.

Appendices



APPENDIX 1

Council Resolution 17-03

9 June 2017

COUNCIL RESOLUTION 17-03

Instruction to the Secretariat of the Commission for Environmental Cooperation regarding submission SEM-16-001 (*Agricultural Waste Burning in Sonora*) which asserts that Mexico is failing to effectively enforce some provisions of the Environmental Protection Bylaw of the Municipality of Caborca, Sonora (*Reglamento de Equilibrio Ecologico y Proteccion al Medio Ambiente*) and the Mexican Official Standard NOM-015-SEMARNAT/SAGARPA-2007, *establishing the technical specifications for the use of fire on forested and agricultural land, in connection with the burning of crop residues in Caborca, Sonora, Mexico*

THE COUNCIL:

SUPPORTIVE of the process provided for in Articles 14 and 15 of the North American Agreement on Environmental Cooperation (NAAEC) regarding submissions on enforcement matters and the preparation of factual records;

AFFIRMING that the process provided for in Articles 14 and 15 of the NAAEC was established by the Parties of the NAAEC to provide an opportunity for residents of Canada, Mexico, and the United States to present their concerns regarding effective enforcement of environmental law and to bring facts to light regarding those concerns;

RECOGNIZING that the Submissions on Enforcement Matters (SEM) process is designed to promote information-sharing between members of the public and the governments on matters concerning the effective enforcement of environmental law;

ACKNOWLEDGING that factual records are an important way to increase public participation, transparency, and openness on issues related to the enforcement of environmental law in Canada, México and the United States;

HAVING CONSIDERED the revised submission filed on 29 April 2016 (“Revised Submission”) by a person who requested that their name be kept confidential, pursuant to NAAEC Article 11(8) (“Submitter”), and the response provided by the Government of Mexico on 5 September 2016;

HAVING REVIEWED the 27 February 2017 notification of the Secretariat recommending the development of a factual record (“Notification”) in connection with certain assertions of the Submitter in its Revised Submission;

HEREBY UNANIMOUSLY DECIDES:

TO INSTRUCT the Secretariat to prepare a factual record in accordance with Article 15(4) of the NAAEC, with the *Guidelines for Submissions on Enforcement Matters under Articles 14 and 15 of the North American Agreement on Environmental Cooperation* (“Guidelines”) and consistent with the terms recommended to the Council by the Secretariat in its Notification;

TO DIRECT the Secretariat to conclude the preparation of the draft factual record as provided in Section 19.5 of the Guidelines, and present it to the Parties in accordance with Article 15(5) of the NAAEC; and

TO DIRECT the Secretariat to provide the Council with its overall work plan for gathering the relevant facts, to keep the Council informed of any future changes or adjustments to such plan, and to promptly contact the Council in connection with any clarification required with respect to the scope of the factual record hereby authorized.

On behalf of the Council:

Catherine Stewart
Government of Canada

Enrique Lendo Fuentes
Government of the United Mexican States

Jane Nishida
Government of the United States of America

APPENDIX 2

Revised Submission SEM-16-001 (*Agricultural Waste Burning in Sonora*)

A14/SEM/16-001/18/RSUB

DISTRIBUTION: General
ORIGINAL: Spanish

[TRANSLATION FOR REFERENCE PURPOSES]

To: Secretariat of the Commission for Environmental Cooperation

Further to the Secretariat's reply in regard to the burning of asparagus crop residues in the Caborca (Sonora) region of Mexico, I am writing to clarify certain issues. Having reviewed the applicable legislation more carefully, and further to the determination that certain information concerning the specific statutes and articles applicable to this matter was lacking, we wish to clarify that the legal provisions that we consider to be the subject of ongoing violations are Articles 144, 146, 150, 151, 167, 168, 169, 170, 172 of the Environmental Protection Bylaw of the municipality of Caborca, Sonora.

We make this assertion because it is an obligation of the municipality and the growers to measure air quality yet they are failing to do so (Arts. 144, 146, and 172). It is therefore impossible to ascertain the degree to which the maximum permissible limits for air quality established by the applicable laws are being exceeded (Art. 150). The remaining articles mentioned above bear upon this matter as follows:

- Open-air burning: Art. 151 establishes a prohibition on open-air burning, which may cause environmental instability or have an impact on air quality, and this is in fact occurring.
- The measures necessary to prevent and control air pollution are lacking (Art. 167). As this article provides, the Branch (referring to the Urban Development and Environment Branch), in coordination with Civil Protection, must take the measures necessary to prevent and control environmental contingencies affecting the population where the air quality parameters set out in the applicable standards are exceeded, as very often occurs during the seasons in question.

- Unauthorized open-air combustion (Arts. 168–169). This is a crucial point in our submission. Burning permits are only to be issued when applied for at least 15 days before burning commences, and only when the burning in question meets the applicable environmental standards, which is not the case here. However, when we requested copies of the permits for previous years and for 2015, in order to ascertain whether the burning complies with the standards, I was told, in these words, that no such permits had ever been applied for, and that the only thing the Branch had ever received was notice of the burning calendar. One association requested this information in writing and did not receive a reply. It is for this reason that I ask you to make the same request in regard to these requirements.
- This burning should be prohibited (Art. 170) for the reasons we have stated, in support of which please find attached some press clippings and photos of these events, along with narrated videos. In addition, on this point, it is important to mention that many residents complain of burning eyes and throat, headaches, and so forth, lasting for many days during the burning season. We must suppose that this is due to the large quantity of agrichemicals used on this crop, since information about the product or products applied has never been forthcoming. And, as is clear, the burning responds to the dictates of weather, not the regulations in force.

In addition to the text of the bylaw, I am attaching the letter containing the reply we received from Profepa on 12 January 2016, giving notice of its lack of jurisdiction over the burning of crop residues, and more particularly asparagus, in the Caborca (Sonora) region of Mexico. Also attached is Mexican Official Standard NOM-015-Semarnat-Sagarpa, the document on which they base their statements and their continued indiscriminate burning of asparagus crop residues in violation of sections 4, 4.1.3, 4.1.14, 4.2, 5.1.3, 5.1.5, 5.2, 5.2.2, 7, and 7.4 thereof, these falling under the headings of objects and scope of application. Furthermore, there are ongoing violations of point 2.4.3 of section III of the Technical Appendix to NOM-015-Semarnat-Sagarpa, titled “Burning Methods and Their Characteristics,” with respect to the schedule, since the schedule is not being observed and the decision to burn is made based on the weather, as occurred this past year-end when the city was totally enveloped in suffocating smoke, and the growers acknowledge that this decision was made on the basis of weather issues, as may be read in the attached article from the newspaper *El Imparcial*. Thus, there are also ongoing violations of point 2.4.6 in relation to smoke management, since this is a factor that cannot be controlled, as occurs during this period of the year.

I trust that these clarifications have answered your concerns and that we can continue to work together so that everyone can enjoy a healthy environment, with economic and business development that is responsible where the environment and its ecosystems are concerned.

[name confidential pursuant to NAAEC Article 11(8)(a)]

APPENDIX 3

Environmental Law in Question

Environmental Law in Question

SEM-16-001 (*Agricultural Waste Burning in Sonora*)

[TRANSLATION FOR REFERENCE PURPOSES]

Environmental Protection Regulation, published in the Official Bulletin of the State Government of Sonora, vol. CXCIII, no. 14, section II (17 February 2014), online at <http://goo.gl/RfMpHJ> (viewed 18 June 2017).

Article 144. For the prevention and control of air pollution, the following criteria shall be considered:

- I. Air quality shall be satisfactory in all human settlements and all areas of the municipality.
- II. Air pollutant emissions, whether from artificial or natural sources, and whether from fixed or mobile sources, shall be controlled in order to guarantee air quality that is satisfactory for the well-being of the population and for ecological stability.
- III. Protecting air quality is the responsibility of the municipality and of society at large.
- IV. Programs concerning reforestation, verification of pollutant emissions, development of clean technologies compliant with environmental criteria, and soil protection shall be contemplated with a view to achieving environmental efficiency, so as to preserve the integrity and stability of the components of the atmosphere.
- V. The preservation and sustainable use of the atmosphere is the joint responsibility of the authorities and the citizens.

Article 146. The Department shall have the following responsibilities, within the scope of its jurisdiction:

- I. To control air pollution on municipal property, as well as from fixed sources under municipal jurisdiction that function as industrial, commercial, or service establishments.
- II. To apply the general criteria established by this Bylaw for the protection of the atmosphere, in municipal urban development plans.
- III. To require the parties responsible for the operation of fixed sources under municipal jurisdiction to refrain from exceeding the maximum permissible limits for pollutant emissions, in accordance with the applicable Mexican Official Standards, state environmental standards, and other environmental criteria or guidelines established in this Bylaw.
- IV. To establish and operate air quality monitoring systems, using technological devices compliantly with the Mexican Official Standards and state environmental standards for this purpose.

- V. To produce environmental monitoring reports and keep them up to date.
- VI. To formulate and apply air quality management programs based on Mexican Official Standards and state environmental standards in order to establish environmental quality on the territory of the municipality.
- VII. [...]

Article 151. The open-air burning of urban solid waste is prohibited, as is that of the vegetation resulting from the clearing, felling, or removal of topsoil from any land, for the purposes of construction or for any other purpose. The municipality may only approve such burning when it does not create an environmental risk or impact on air quality and is justified on applicable grounds, in the opinion of the competent authorities. The incineration of any waste by controlled methods, with the exception of such waste as is considered hazardous under the General Act or other federal legislation, shall remain subject to the emissions provisions of the State Act.

Article 167. Where the air quality parameters established by the Mexican Official Standards are exceeded, the Municipal Council, acting by the [DDUE] and in coordination with the Municipal Civil Protection Unit, shall take the measures necessary to prevent and control environmental contingencies caused by air pollution for a given sector and/or for the whole population of the municipality.

Article 169. To obtain the permit mentioned in the preceding article, the interested party shall apply to the Department in writing at least fifteen working days before the intended date of the event, with a copy to the competent agricultural authority and the municipal civil protection unit, fully justifying the necessity of the activity. The Department shall review the application and issue a decision within a period not to exceed fifteen working days, either unconditionally approving, conditionally approving, or denying the permit.

Article 170. The Municipal Council shall not permit open-air burning where toxic pollutants are generated that may cause adverse health effects, harms, or nuisance in the exposed population, nor in the case of urban solid waste. Any permit that has been issued may be suspended, in whole or in part, temporarily or permanently, where an extraordinary contingency is caused by the burning, or where environmental and meteorological conditions do not allow for adequate dispersal of the pollutants.

Article 172. The Department shall establish and operate air quality monitoring systems with a view to evaluating the ambient air quality of population centers in accordance with the parameters set out in the applicable Mexican Official Standards, with the technical support of the environmental authorities and the academic or research institutions, and shall deliver the local air quality monitoring reports to these entities for incorporation into the National Environmental Information System in accordance with the applicable coordination agreements.

APPENDIX 4

Notice of Agricultural Burning [TRANSLATION FOR REFERENCE PURPOSES]

NOTIFICATION OF FIRE USE IN FORESTLAND AND AGRICULTURAL USE ZONES. NOM-015-SEMARNAT/SAGARPA-2007

ANNEX 1

I. General applicant information

- a) Name or corporate name of owner(s) of the site or group of sites: _____

- b) Name: _____
- c) Address: _____
- d) Official identification (copy) of applicant who will be effecting the burn: _____

II. General information on the site

- a) Name of site: _____

b) Type of land tenure

Small holding () *Ejido* (commons) () County ()

Federal () State () Municipal ()

c) Location of the plot where the burn will be carried out:

Exact location: _____ Locality: _____

Municipal division: _____ (where appropriate)

Municipal department: _____ (where appropriate)

Municipal district _____ (where appropriate)

Municipality: _____ State _____

Region: _____ (where appropriate)

d) Type of land where burn will take place

Forestland () Land preferably suitable for forestry ()

Temporary forestland () Neighboring and/or adjacent land ()

Agricultural use () Pasturelands used for grazing ()

e) Surface area to be burned: _____ hectares

III. **General information on fire use**

a) Burn method to be used:

- Controlled burning method ()
Prescribed burning method ()

b) Purpose or objective of burn:

Agricultural:

- Elimination of waste from previous harvests ()
- Regeneration of improved grasslands ()
- Facilitation of harvesting activities (e.g., sugar cane) ()
- Pest and parasite control ()
- Elimination of woody and herbaceous plants competing with grasslands ()
- Elimination of vegetation prior to planting activities ()
- Control of noxious weeds ()

Miscellaneous:

- Charcoal production
- Research
- Training and coaching

Forest management and protection or environmental purposes

1. Forest fire prevention

- Reduction of wildfire fuel build-up to avert catastrophic forest fires ()
- Opening of control lines and burn outs ()

2. Forest management

- Preparation of sites for regrowth ()
- Control of plant succession to promote restoration of ecosystems invaded by non-desired species ()
- Pest and disease control ()
- Rangeland management in forested areas ()
- Ecological management of natural meadows (native grasslands) ()

3. Environmental and/or site improvements

- Enhanced regrowth and management of desired fire-adapted species ()
- Improved access to wooded areas
- Vegetation improvements for recreational or tourism purposes ()
- Improved wildlife habitat ()
- Enhancement and/or changes in scenic beauty ()

4. Others

Specify: _____

c) **Scheduled date for burn:** _____

Burn start time: _____

Time of completion: _____

d) **Number of persons involved in the burn:** _____ persons

e) **Ignition technique or burn pattern:**

- | | | | |
|----------------|-----|--|-----|
| Backing fire | () | Strip backing fire | () |
| Strip headfire | () | Flank fire | () |
| Spot firing | () | Circular burning with central ignition pt. | () |
| Chevron burn | () | | |

Location: _____

Date of this request: _____

Name and signature

N.B. The applicant shall present the original and a copy that has been stamped or signed as confirmation of receipt by the competent authorities.

APPENDIX 5

Minutes of the Working Meeting to Establish the Ordinance Regulating the Controlled Burning of Asparagus in the Caborca Region, 2015–2016 Season

[TRANSLATION FOR REFERENCE PURPOSES]

MINUTES OF THE WORKING MEETING TO ESTABLISH THE ORDINANCE REGULATING THE CONTROLLED BURNING OF ASPARAGUS IN THE CABORCA REGION, 2015–2016 SEASON

This meeting was held at the Mayor's office, located at Calle Obregón and Avenida Quiroz y Mora, in the city of Caborca, Sonora, at 7:00 p.m. on 24 November 2015. It was attended by Karina García Gutiérrez, Mayor of the Municipality of Caborca; Ricardo Araiza Celaya and Librada Macías González, respectively Municipal Secretary and City Councillor; Dr. Luis Alberto Cádiz Lizárraga, Director, Public Health Jurisdiction no. 2; José Ramsés Ortega Celaya, Director, CADER 02 Caborca, representing Sindia Anel Gutiérrez Saldaña, director of DDR 139 Caborca; Fabián Robles Contreras, Field Director, Inifap; Enrique Ricardo Gil Mejía and Carlos Alberto Nicols Santos, respectively President and Executive Director of the Asociación Agrícola de Productores de Frutas y Hortalizas de Caborca A.C.; Aarón Mier Nogales and Alfonso Reyes Pesqueira, from the Asparagus Commission of the same organization; Eduardo Liñeiro Celaya, President, Local Phytosanitary Committee; and Raul H. Buentello Ruiz, President, Asociación de Usuarios del Distrito de Riego 037, Altar, Pitiquito, Caborca, A.C.

Mr. Nicols Santos opened the meeting, commenting that the controlled asparagus burning program is to be implemented for the sixth consecutive year, with reference to **NOM 015-Semarnat-Sagarpa-2007**.

Mr. Gil Mejía stated that the asparagus growers agree and are willing to observe strict compliance with the control program proposed by the Local Phytosanitary Committee, which sets out stricter standards with a view to substantially diminishing the effects of the controlled burning of asparagus. These rules are enumerated below.

1. Facilitating the work of the Local Phytosanitary Committee staff.
2. Burning a daily maximum of 3.5% of the total area; i.e., if we have 9,000 ha in the whole region, 315 ha may be burned each day.
3. We believe that this can be achieved with proper planning at the time the asparagus plants are cut down.

4. The Sapos-La Almita regions are the most critical, so the three companies operating there (Las Tres Californias, Hortícola del Desierto, and Exportadora de Caborca) must not all burn on the same day.
5. The burning schedule is from **11:00 a.m. to 3:00 p.m.** even if conditions are favorable later in the day.
6. Banking of unused allotted areas for later burning is not permitted, nor is extra burning in anticipation of rainy weather.
7. Growers must submit their burning plans no later than November 30, which will enable us to analyze the various plans and make any necessary adjustments.
8. Payment of 300 pesos per ha on the basis of actual area and short-term recovery.
9. Fines for growers who violate any of these conditions.
10. The Municipal Council is in charge of setting the amounts of fines and collecting them.
11. There will be follow-up to fines as necessary.
12. We are not liable for any consequences resulting from failure to comply with the program.
13. The roles of each of the parties involved in the asparagus burning process must be made very clear and must be made known to all relevant parties.
14. All growers must sign a document stating their agreement with the request of the Local Phytosanitary Committee, and they undertake to comply with all of the points mentioned.
15. In the event that a grower causes an anomaly and is fined accordingly, but the fine is not collected, the Local Phytosanitary Committee will resign from coordination of the program.

Mr. Liñeiro Celaya made some general comments about previous years' results of the controlled burning of asparagus program, specifically regarding wind speed and direction and the optimal schedule for this practice.

Mr. Robles Contreras commented that Manuel de Jesús Valenzuela Ruiz had conducted a study for Inifap analyzing the effect of asparagus foliage burning at harvest time on yield. The study found that in the absence of burning, the harvest began six days late and production was poor. This caused a shift in the marketing window, the consequence being that growers could not get the best price for their product. He concluded his comment by arguing that burning is considered part of the technology package for asparagus, this practice being necessary for the elimination of disease propagules and for breaking the biological cycle of the main pests and diseases affecting this crop.

Dr. Cáñez Lizárraga commented that the Public Health Jurisdiction had conducted an in-depth review to ascertain whether the smoke from asparagus burning is a risk factor to be considered in significant diseases of the respiratory tract. Regarding this issue, it did not find any significant evidence, instead it found that the respiratory tract conditions encountered were primarily caused by the low temperatures prevailing during this period of the year; and, regarding other diseases affecting human health, it found that these other diseases occur year-round.

Ms. Gutiérrez García acknowledged the effort of the asparagus growers as major employers promoting the regional economy, with the spinoff benefits generated by this industry. She told the asparagus growers that they have the municipality's consent to carry through with the production process all the way through to the harvest stage, provided that they perform the contractual undertakings detailed in this document so as to conduce to the efficient administration of the controlled burning program. She called on those present to work together to deal with any public demands that might arise in the course of the program. She also discussed options for a reforestation and greenspace program to include the urban area and the rural zone of this municipality. The purpose of reforestation is to mitigate the effects of asparagus burning.

With no further matters to address, and the time being 8:15 p.m. on 24 November 2015, the meeting was adjourned and those present signed these minutes to attest to their attendance.

MAYOR'S OFFICE

KARINA GARCIA GUTIERREZ
MAYOR OF CABORCA

RICARDO ARAIZA CELAYA
MUNICIPAL SECRETARY

LIBRADO MACIAS GONZALEZ
COUNCILLOR

MINISTRY OF HEALTH

DR. LUIS ALBERTO CAÑEZ LIZARRAGA

DIRECTOR, PUBLIC HEALTH JURISDICTION
No. 2

SAGARPA

JOSE RAMSES ORTEGA REYNA

DIRECTOR, CADER 02, CABORCA

INIFAP

FABIAN ROBLES CONTRERAS
FIELD DIRECTOR, CABORCA

ASOCIACION DE PRODUCTORES DE
FRUTAS Y HORTALIZAS DE CABORCA, A.C.

ENRIQUE RICARDO GIL MEJIA
PRESIDENT

AARON MIER NOGALES
ASPARAGUS COMMISSION

ALFONSO REYES PESQUEIRA
ASPARAGUS COMMISSION

CARLOS ALBERTO NICOLS SANTOS
EXECUTIVE DIRECTOR

LOCAL PHYTOSANITARY COMMITTEE
EDUARDO LIÑEIRO CELAYA
PRESIDENT

APPENDIX 6

Calculations of emissions CEC 2017: Calculations of emissions from agricultural burning of asparagus in Caborca, Sonora

CEC calculations: 2017	CO ₂	CO	CH ₄	N ₂ O	NO _x	PM ₁₀	PM _{2.5}	SO ₂	CO	NO _x	COV	NH ₃
Emission factor (g/kg) (kg/Mg) (kg/t)	1,515.0	92.0	2.7	0.1	2.5	20.0	19.7	0.3	75.0	2.2	33.0	1.2
Source of the emissions factor	[1]	[1]	[1]	[1]	[1]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
2017 Emissions from asparagus residue burning in the municipality of Caborca (t/year)	51,813.8	3,146.4	92.3	2.4	85.5	684.0	672.7	10.4	2,565.0	76.8	1,128.6	40.5

Emissions inventories consulted by the Secretariat

Emissions from agricultural burning in the municipality of Caborca (INEM 2013)			10.5			36.2	34.4	2.0	296.5	11.7	23.1	5.9
Emissions from the municipality of Caborca from all sources (ProAire Sonora 2017-2016 Annex B)						18,844.9	3,310.2	59.7	10,595.2	7,352.4	12,756.5	545.3
Emissions from all agricultural burning sources in the state of Sonora (INEM 2013)						6,335.0	6,026.2	388.5	61,291.5	2,237.9	5,157.8	1,226.7
Emissions from agricultural burning in the state of Sonora (ProAire Sonora 2017-2026 Annex A)						4,003.9	3,803.2	283.3	41,742.0	1,504.2	3,488.4	835.4
Emissions from area sources in the state of Sonora (ProAire Sonora 2017-2026 Annex A)						35,315.8	15,851.5	1,052.7	112,316.3	6,078.1	56,296.6	27,743.5

[1] Aalde, H. et al. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 2: Generic Methodologies Applicable to Multiple Land-Use Categories. Table 2.5 p. 47

[2] California Air Resources Board. Smoke emission Estimation. Agricultural Burning and Other Managed Burns. Managed Burn Emission Factor Table. <https://www.arb.ca.gov/ei/see/see.htm> Sitio web consultado el 30/10/2017.

GHG emissions, CEC 2017 calculations	CO ₂	CO	CH ₄	N ₂ O
Global warming potential*	1	1.8	28	265
Emissions in Mg of CO ₂ equivalent	51,813.8	5,663.6	2,585.6	634.4

* Taken from: IPCC (2013), *Climate Change 2013: The Physical Science Basis*, Appendix 8, A Lifetimes, Radiative Efficiencies and Metric Values. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. p. 731.

Data for calculations of emissions from agricultural burning of asparagus in Caborca, Sonora

Parameter	Value	Unit	Source
Specific biomass*	3,362.6	kg/ha	CELDA N41
Cultivated area	10,171.0	ha	OIAPES - SAGARHPA
Total biomass	34,200,510.9	kg	Calculation of A. Keer
Total biomass	34,200.5	t	Calculation of A. Keer

* Specific biomass (the real quantity of burned biomass) corresponds to the fuel load. Value from the California Air Resources Board. See table below.

Emission factors and fuel load for agricultural burning.

Crops subject to agricultural burning				Emission Factors								Fuel load	Fuel load unit
Crop Code	Crop Name	EIC Description	EIC Code	Emission Factor Units	PM ₁₀	PM _{2.5}	NO _x	SO ₂	VOC	CO	NH ₃		
610	Sugar cane	Agriculture - Field Crop	670-662-0262-0000	lbs/ton	15.90	15.18	4.49	0.61	10.73	113.95	1.80	2.175	tons/acre
				Mg/Mg	0.007950	0.007590	0.002245	0.000305	0.005365	0.056975	0.000900	4,875.700	kg/ha
247	Asparagus	Agriculture - Field Crop	670-662-0262-0000	lbs/ton	40.00	39.34	4.49	0.61	66.00	150.00	2.37	1.500	tons/acre
				Mg/Mg	0.020000	0.019670	0.002245	0.000305	0.033000	0.075000	0.001185	3,362.551	kg/ha

Source: EIC = emission inventory categories.

Source: CARB (2008), Smoke Emission Estimation: Agricultural Burning and Other Managed Burns, "Managed Burn Emission Factor Table" [in Excel: mngdburnemissionfactors.xls], California Air Resources Board, June 2008; available at: <<https://goo.gl/W9LPaZ>> (viewed on 5 December 2017).

Conversion factors

kg/lb	0.453592
kg/ton	907.185
ha/acre*	0.404686

* this particular case, "t" corresponds to the US ton, which corresponds to 907 kilograms.

Category	Subcategory	Key	State Cve	State	Municipal Cve	Municipality	
SonoraCaborca	Fuentes de área	Quemas agrícolas	FA0707	26	Sonora	017	Caborca

Source: extracted from the INEM, 2013 spreadsheet



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