



United States and United Nations pesticide policies: Environmental violence against the Yaqui indigenous nation

Victor A. Lopez-Carmen,^{a,b,c,1,*} Timothy B. Erickson,^{a,b,d} Zara Escobar,^e Anpotowin Jensen,^{f,1} Alexandria E. Cronin,^g LaShyra T. Nolen,^a Marcos Moreno,^{h,1} and Amanda M. Stewart^{a,i}

^aHarvard Medical School, Boston, MA, USA

^bHarvard Humanitarian Initiative, Cambridge, MA, USA

^cUN Global Indigenous Youth Caucus, Manhattan, NY, USA

^dDepartment of Emergency Medicine, Division of Medical Toxicology, Mass General Brigham, Boston, MA, USA

^eGeorge Washington University, Washington, DC, USA

^fStanford University, School of Engineering, Palo Alto, CA, USA

^gMedical Library, Boston Children's Hospital, Boston, MA, USA

^hDepartment of Psychiatry, Yale University, New Haven, CT, USA

ⁱDivision of Emergency Medicine, Boston Children's Hospital, Boston, MA, USA

Summary

Indigenous Peoples suffer environmental violence related to pesticide exposure, including imported pesticides that are banned in the exporting countries (including the U.S.) due to their known detrimental health impacts and used in or near their traditional territories. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is a U.S. statute that allows “pesticides that are not approved – or registered – for use in the U.S.” to be manufactured in the U.S. and exported elsewhere. The UN Rotterdam Convention also allows the global exportation of “banned pesticides.” The ongoing exportation of banned pesticides leads to disproportionately high rates of morbidity and mortality, most notably in Indigenous women and children. In this paper, we present evidence describing the documented harms of banned pesticides with a focus on the Yaqui Nation in Sonora, Mexico, give background on the problematic laws allowing these harms, and highlight concrete solutions.

The Lancet Regional Health - Americas 2022;10: 100255

Published online 18 April 2022

<https://doi.org/10.1016/j.lana.2022.100255>

Copyright © 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Keywords: Health policy; Pesticides; Indigenous peoples; Yaqui; United Nations; Environmental violence

“The airplanes spray chemicals on the crops, and it affects the town and its inhabitants. In and around the whole town there are large tanks holding hazardous chemicals. Many people have died here. . .” - Testimony from a 48-year-old Yaqui mother of 6

“These deformities are the product of tumors produced by chemicals when young women are exposed to their application while working in the field without personal safety measures or other similar protection” - Testimony from a Yaqui mother of a young woman born with deformities

“. . . we as mothers must be very attentive to the children who are defenseless. Our community is hit with chemicals by airplanes, fathers and mothers work in the field. . . many older people are affected, there is a lot of cancer.” - Testimony from a Yaqui mother from pueblo Loma de Bacum

Introduction

The United States (U.S.) allows the production and export of pesticides to low- and middle-income countries (LMIC), even when those pesticides have been banned domestically due to their known detrimental health impacts.¹ Export data from U.S. ports found that over 27 million pounds of pesticides forbidden for use domestically were shipped at an average of 32 thousand pounds per day.¹ In 2012, the Environmental Protection Agency (EPA) reported that banned pesticides were

*Corresponding author at: Harvard Medical School, Boston, MA, USA.

E-mail address: Victor_Lopez-Carmen@hms.harvard.edu (V.A. Lopez-Carmen).

¹ Victor A. Lopez-Carmen is a member of the Crow Creek Sioux Tribe and is also from the Yaqui Nation. Anpotowin Jensen is a member of the Oglala Lakota Nation. Dr. Marcos Moreno is a member of the Pascua Yaqui Tribe.

being produced in 23 U.S. states.^{2,3} Many pesticides still widely used in the USA, have been banned or are being phased out in the EU, China, and Brazil. For decades, these pesticides have been exported to other countries, where they have been associated with significant adverse health effects on Indigenous Peoples, such as the Yaqui Nation of Sonora, Mexico.

Today, the export of domestically banned pesticides to other countries remains legal under U.S. laws and United Nations (UN) conventions, namely the U.S. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the UN Rotterdam Convention. Our objective is to describe the current evidence surrounding the negative health impacts of banned pesticide export on Indigenous Peoples and the laws that permit this practice, with an emphasis on the Yaqui Nation. Specifically, our review aims to answer the following three questions: (1) What are the evidence of health impacts from banned pesticides? (2) What are the relevant laws and how are they problematic? (3) What solutions have been proposed to address the issue? Using the gathered information, we present five U.S. and UN policy actions and two recommendations to the global medical community to prevent environmental violence towards the Yaqui Nation and Indigenous Peoples at large.

Search strategy and selection criteria

References for this manuscript were identified through searching PubMed, CINAHL, ProQuest Agriculture & Environmental Science Database (a specialized subset of ProQuest databases provided through Harvard University), and Web of Science. No limits were imposed on the search. No date range was specified, and no language limit was set. Additional white and grey literature were found through searching Google Scholar with the search terms “Yaqui”, “Pesticides”, “United Nations”, “Mexico”, “FIFRA”, and “Rotterdam Convention,” such as reports from the UN, media articles, and information from international Indigenous rights organizations. Between these two search strategies, 359 individual references met the search strategy criteria after duplicates were removed. Out of the 359 references, 121 were screened for full text review, and 51 were included for data extraction. The final reference list was generated manually by three authors screening for originality and relevance to the policy and health scope of the topic. Articles in Spanish were reviewed by Spanish speaking team members. Full search strategies are included in *Appendix A*.

The Yaqui Nation

The Yaqui or *Yoeme* are an Indigenous nation whose traditional territories include lands in the coastal region of present-day Sonora, Mexico, as well settlements and a reservation in Arizona, U.S. Historically, the Yaqui Nation established their communities along the fertile

valley soil adjacent to the Rio Yaqui or Yaqui River, also known as the Yaqui Valley, in western Sonora, Mexico. The Yaqui Nation, like Indigenous Peoples across the globe, have defended their peoples, culture, and land rights through centuries of colonization and attempted genocide by imperialistic powers.

Today the Yaqui Valley has one of the highest agricultural densities in Mexico due to the availability of water from the Yaqui River and the fertile soil surrounding it.⁴ These ancestral lands, referred to as *Hiakim* by the Yaqui Nation, have long been of great importance not only for the sustenance it has provided their communities, but the spiritual and metaphysical connection it serves to their way of life. Current demographic data estimate that there are over 20,000 Yaquis living among eight Pueblos - Pótam, Vícam, Tórim, Bácum, Cócorit, Huirivis, Belem, and Rahum - in Northwest Sonora, Mexico. All eight pueblos lack water treatment, with studies linking the high levels of pesticides and heavy metals (e.g., lead, mercury, arsenic) in the region's soil and drinking water to high rates of child cancers in the Yaqui Valley.^{4,5} For over a decade, Yaqui tribal leaders have advocated against the importation of banned pesticides from other countries, citing the practice as a form of environmental violence that harms the health of their Nation.

Defining “environmental violence”

The term, “environmental violence” was created and adopted by 52 Indigenous women and girls aged 14-95 years at the International Indigenous Women's Symposium on Environmental Reproductive Health in 2012, sponsored by the International Indian Treaty Council. It is defined as a pervasive form of systemic racism where state and corporate practices disproportionately expose marginalized communities to environmental contaminants that are well-documented to cause morbidity, mortality, and intergenerational health impacts.⁶

Environmental violence in the context of international pesticide trade was formally recognized during an Expert Group Meeting (EGM) of the UN Permanent Forum on Indigenous Issues (UNPFII) in January 2012, on the subject of “Combatting Violence Against Indigenous Women and Girls.” The report emphasized the harmful impacts of toxins that are released into the environment and cause severe and ongoing environmental violence to “Indigenous women, girls, and unborn generations.” This official UN report clearly identified reproductive cancers, disabilities, birth defects, and “untold suffering and death” as “well-documented” impacts of banned pesticide trade practices.⁶

A critical race theory lens

Critical Race Theory (CRT) offers a powerful lens to understand the impact of banned pesticides on

marginalized communities in LMIC, where primarily Black, Indigenous Peoples, and racially minoritized people live. In the context of the Yaqui Nation, CRT calls us to consider their sociopolitical contexts as Indigenous Peoples in the U.S. and Mexico, where legacies of colonization, anti-Indigenous racism, and colorism continue to manifest in systemic oppression. The policies that permit the use of banned pesticides on Yaqui traditional lands underscore this problematic history and emphasize a racial and ethnic based hierarchy that values financial profit over Indigenous lives. Therefore, this call to action requires us to acknowledge the public health crisis as a reproduction of the historical oppression previously and continually experienced by Indigenous Peoples.

Within a CRT lens, we must also consider how social disparities and inequities are informed by intersections of identity, position, and social markers. Crenshaw conceptualized intersectionality as “the interconnected nature of social categorizations such as race, class, and gender as they apply to a given individual or group, regarded as creating overlapping and interdependent systems of discriminations or disadvantage.”⁷ For example, colorism and sexism, both well-documented phenomena, describe the practice of creating hierarchies based on skin tone and sex, with darker skin tones and those who identify as women placed at the bottom. It is possible that because of colorism and sexism, detailed analysis of banned pesticide exposure would reveal that women with darker skin tones in Mexico, such as Indigenous women and girls, have higher exposure and increased health disparities as a result. In the Yaqui Valley, Yaqui women commonly work in nearby agricultural fields, generally without adequate or no personal protective equipment.⁸ Yaqui women are also more likely to have the domestic roles of preparing and gathering food and water for the family, potentially increasing their exposure. Women living in agricultural areas in Mexico, such as the Yaqui valley, have also been found to breastfeed their children more frequently and for longer periods of time than women in Mexico’s urban areas, suggesting an increased risk of pesticide transmission via contaminated breastmilk due to cultural practices around breastfeeding.^{9,10} According to the World Health Organization (WHO), pesticide exposure can also result in maternal-fetal toxicity both in-utero and through breast milk, putting women who work in agricultural fields during their pregnancies to support their families at greater risk, as well as their babies in utero.¹¹

This is just one example of the ways intersecting marginalized identities may play a role in the harms of imported pesticides, but this problem can be further examined to reveal differences by disability status, sexual orientation, and economic status. Understanding the intersectional challenges can inform targeted policy changes that more effectively prevent harmful pesticide

trade practices from disproportionately impacting certain individuals and groups, such as Indigenous women and girls.

What is a banned or restricted pesticide?

A 2012 study by Pesticide Action Network (PAN) International estimated that the number of people globally affected annually by short- and long-term pesticide exposure ranges up to 40 million.¹² Although all pesticides can be harmful when used inappropriately, some are more lethal than others, leading to international and state policies that restrict their uses. For example, in 2004, the UN Stockholm Convention on Persistent Organic Pollutants banned the use of mirex, toxaphene, polychlorinated biphenyls, dichlorodiphenyltrichloroethane (DDT), aldrin, endrin, dieldrin, heptachloro, and hexachlorobenzene (HCB) due to their known harmful environmental health impacts.¹³ PAN, The Consolidated List of Banned Pesticides (CL), and UTZ, all provide updated annual information on pesticides that have been banned in various countries.¹²⁻¹⁴

In the U.S., the Environmental Protection Agency (EPA) regulates the import and export of pesticides.¹⁵ A “banned” pesticide is defined as a pesticide for which all registered uses have been prohibited by final EPA action to protect human health or the environment. It includes pesticides that have been refused approval for first-time use or have been withdrawn by industry. A “severely restricted” pesticide means virtually all registered uses have been prohibited by final EPA regulatory action, but for which certain specific registered uses remain authorized.¹⁶ For example, as of August 18, 2021, the EPA banned the toxic organophosphate pesticide chlorpyrifos from food products and is currently reviewing the safety of two dozen other organophosphate pesticides.¹⁷ Total pesticide bans remain the most effective way to prevent intentional or accidental exposure and promote the transition to safer alternatives.^{18,19}

Impaired lives and deaths for Yaqui women and children

Pesticide use in rural communities of Sonora, Mexico is common, and the quantities of use are large enough to negatively impact human health.^{20,21} The risk for handling pesticides, especially banned pesticides, is high in the area, partially due to documented lack of personal protective equipment and training for agricultural workers.⁸ A study in 2018 by Lopez-Galvez et al., documented that farm workers in Northern Sonora, Mexico had significantly higher detectable blood concentrations of pesticides than the general U.S. population and Mexican Americans.²² The study also noted that speaking an Indigenous language was a risk factor for higher levels of blood pesticide concentrations, suggesting that

Indigenous identity and cultural markers can compound pesticide related health risks for farm workers in the region.²² In the Yaqui Valley, high levels of banned pesticide residues have been identified in soil samples and water sources, putting Yaqui field workers and all Yaqui people who live in the region at high risk of exposure.^{23–25}

As early as 1991, studies have reported the presence of banned pesticides in blood and breastmilk samples of Yaqui women and children, including DDT, hexachlorohexane, aldrin, dieldrin, endrin, HCB, and heptachlorine.¹³ Since 2005, dozens of testimonies have been recorded and collected from Yaqui community members, health workers, farmworkers, and traditional midwives regarding the health and environmental impacts of banned pesticides. More than 80 testimonies were collected according to official UN testimony standards by Indigenous rights organizations, including the International Indian Treaty Council (IITC), and submitted to the various UN human rights bodies. A breakdown of 20 testimonies that are open access are included in Table 1.²⁶

Chronic exposure to banned pesticides has been linked to cancer, Alzheimer's and Parkinson's diseases, hormone disruption, sterility, neurological health effects, dermatological disorders, respiratory diseases, and death.^{27,28} Pesticides are also a common lethal means of suicide by ingestion in this region and globally.²⁹ The impacts reported in the above testimonies by Yaqui mothers, farmworkers, traditional midwives, and family members are consistent with the known health effects of banned U.S. pesticides and supported by epidemiological studies conducted in Rio Yaqui, Mexico by Guillette et al., in 1998 and 2006,^{30,31} and Meza-Montenegro et al., in 2013.¹³ The studies document high concentrations of pesticides in Yaqui urine, blood, and breastmilk samples, even though those pesticides had been banned by the UN Stockholm convention prior to the sample collection. They also document the reproductive and intergenerational health effects, including links between prenatal exposure to pesticides and deleterious health effects. In urine samples of Yaqui children in the valley areas, taken in 2013, 100% of samples had higher than average levels of DDT, 39.2% of Lindane, 9.8% of aldrin, and 3.9% of endosulfan.¹³ Guillette also found striking motor, coordination, cognitive, and memory developmental impairment in young Yaqui children from the valley areas, where there is high pesticide use, compared to the Yaqui communities in the foothills who experience little to no pesticide use.²⁹

In a follow up study, Guillette's group documented abnormal breast development in pre-teen and teenage girls whose mothers were exposed to banned pesticides from aerial spraying in the Yaqui Valley.³¹ In this study, high levels of pesticides, including endrin, dieldrin, aldrin, and benzene hexachloride (BHC), which are all banned U.S. pesticides, were found in the cord blood of

Yaqui newborns, and the breast milk of Yaqui mothers, as demonstrated in Table 2. Another study in 2012 from Villa-Moreno et al. found cyhalothrin, a restricted U.S. pesticide, and cypermethrin, a banned U.S. pesticide, at levels above WHO accepted standards in Yaqui Valley soil and water.⁵

The evidence brought forth in the above peer-reviewed studies and official testimonies document the well-known impacts of banned pesticides on the Yaqui Nation. The presence of such banned pesticides means that children in proximity to aerial chemical spraying, such as those who reside in the Yaqui Valley, are at higher risk of experiencing health impacts than children in urban areas of Mexico.³² When considering this data and official UN testimonies, it is important to note that none included Yaqui people who live in Arizona, U.S., where the banned pesticides that Yaqui people in Mexico have documented exposure to are prohibited for use. Thus, Yaqui people in Arizona are protected by virtue of being within U.S. borders, while Yaqui people in Mexico from the same Indigenous Nation were not afforded the same protections and now suffer the consequences.

The legal landscape of banned pesticides

Domestically, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) is a U.S. statute that legally permits U.S. states and companies to export "pesticides that are not approved-or registered-for use in the U.S." At the international level, the UN Rotterdam Convention also permits this practice. Each of these policies and their implications are described in more detail below.

FIFRA: FIFRA, enacted in 1947, is a U.S. federal statute that governs the registration, distribution, sale, and use of pesticides in the U.S. Before a pesticide is sold or used in the U.S., it must be registered with the Environmental Protection Agency (EPA). Applicants are required to prove that the pesticide will not cause unreasonable side effects to the environment, with specific attention to the social, economic, and environmental costs a pesticide will have, as well as dietary risk from chemical food residues. In addition, strict labeling requirements were established to ensure farmers, companies, and other users make informed choices when handling the product. Yet, pesticides that do not meet these stringent FIFRA standards, and thus do not qualify for EPA registration, are still permitted to be exported to other countries.³³

The banning of products manufactured in the U.S. for domestic consumption frequently creates large inventories, making less developed countries prime market targets for the sale and distribution of these banned substances. While chemicals designed for use by U.S. citizens often are subject to legislative and administrative restrictions, the policy of the U.S.

Name of Community Member, age, gender (if provided)	Yaqui Pueblo	Role in Community	Date Collected	Affected Individuals	Health Issues or symptoms described	Pesticide transmission	Medical Specialists Seen	Medical specialist opinion	Mortality
Edna del Carmen Villegas de Miranda, female	Not specified	Neighbor	June 26, 2009	10-year-old neighbor	Malignant tumors of the eye	Exposure to unregulated fertilizers and pesticides in the home without precautions	Doctor	Doctors said the girl's symptoms were strongly related to her exposure to pesticides	No
Teofila Palomares Baycuri, 48 years old, female	Not specified	Mother	January 18, 2006	9-year-old son	Headache, fever, loss of consciousness and death a day later.	Ariel spraying of pesticides	Doctor	Doctor noted the pesticides had entered child's body causing the symptoms	Passed away in the hospital
Norma Alicia Garcia Nasaumea, female	Potam	Pregnant mother and field worker	April 20, 2005	Baby	Birth defects, Hydrocephalus, Meningocele, body swelling, kidney damage and bladder issues	Mother working in the fields with dangerous chemicals while unknowingly pregnant	Doctor	Not specified	Passed away at the age of 14 after 4 years of treatment and 4 operations
Anonymous, female	Potam	Field worker	January 16, 2006	Baby	Born with and facial deformities and a highly atrophied cerebellum	Field work without protection	Doctor	Doctor said the baby's developmental issues and death were due to exposure to pesticides from the father's field work	Baby was dead upon birth

Table 1 (Continued)

Name of Community Member, age, gender (if provided)	Yaqui Pueblo	Role in Community	Date Collected	Affected Individuals	Health Issues or symptoms described	Pesticide transmission	Medical Specialists Seen	Medical specialist opinion	Mortality
Carla E. Arenas Verdia, 42 years old, female	Potam	Wife of field worker	April 18, 2005	Baby and another boy named Cristian	Liver damage, leukemia, deformities	Field work without protection	Doctor	Doctors said that the pesticides used in the fields that the father worked in were found in the baby and caused the problems	Not specified
Eva Morales Alvarez, female	Not specified	Mother	February 23, 2009	Four year old child	Dizziness, fainting, lymphoblastic leukemia	Contact with agro-chemicals and living in an area with frequent aerial fumigation	Doctor	Doctors determined the child had toxins in his blood which caused the leukemia	No
Flor Reyna Osuna, female, and Jesus Gonzales, male	Not specified	Mother and Midwife	December 15, 2011	Daughter	Birth defects, born with watery and jelly-like body, atrophied organs, unable to walk	Home exposure due proximity to spraying on agricultural lands	Physician, Midwife	Physicians considered that the location of the home exposed the child to pesticides	No
Xóchitl Valdés, female	Not specified	Mother	December 20, 2011	Daughter	Born with facial deformities, primarily to her lips	Home contamination from chemical residues	Doctor	Doctors said that contact with agro-chemical residues caused the deformities	No
Aurelia Espinoza Valencia, female	Vicam	Midwife of over 150 cases	January 2014	Mother and baby	Born with deformities all over body, skin discoloration, watery and jelly-like body	Not specified	Doctor, Midwife	Midwives said that birth deformities typically are a result of chemical spraying	The baby passed away 8 h after birth, recounts other deaths as well

Table 1 (Continued)

Name of Community Member, age, gender (if provided)	Yaqui Pueblo	Role in Community	Date Collected	Affected Individuals	Health Issues or symptoms described	Pesticide transmission	Medical Specialists Seen	Medical specialist opinion	Mortality
Jose Mario Alvarez E., 42 years old, male	Potam	Field worker	October 10, 2003	Brother	Leukemia	Did field work with a broken backpack that carried pesticides without protections or education	Doctor	Doctor related the illness to an accident in which the individual's backpack broke, soaking him in the pesticides that he worked with	Passed away after a year of hospitalization, chemotherapy, and several blood and platelets donor attempts
Grandma (unnamed), female	Not specified	Grandmother	January, 2013	Juan Antonio Rodriguez Coronado, grandson	Liver cirrhosis, sick and swollen at birth	Mother performed field work while pregnant	Doctor	Not specified	Passed away in 2016 from cirrhosis of the liver
Alejandra Mariela Espinoza, female	Not specified	Mother, wife to field worker	January 18, 2014	Son	Myelomeningocele, born with a protruberance at the coccyx requiring surgery, malformation in the lower lip	Home contamination, mother fell on contaminated field while pregnant	Doctor	Not specified	No
Luisa Anguis, female	La Loma de Bacum	Mother	August 20, 2013	5-year-old child in community named Lucio Juarez	Leukemia, marks on skin, loss of appetite, weight-loss, cancers in community	Living in an area considered dangerous due to pesticide use	Doctor	Doctors said transfusion treatments were not available to the boy	Passed away while hospitalized
Ramon Valencia Amarillas, male	Not specified	Cousin	January, 2014	Younger cousin	Leukemia, frail body, respiratory problems, fatigue,	Proximity to agricultural plots and a pesticide application aircraft field	Doctor	Doctors did not have the necessary resources to provide medical care and save the child	Passed away at age of 13

Table 1 (Continued)

Name of Community Member, age, gender (if provided)	Yaqui Pueblo	Role in Community	Date Collected	Affected Individuals	Health Issues or symptoms described	Pesticide transmission	Medical Specialists Seen	Medical specialist opinion	Mortality
Rafaela Paredes Borbon, female	Vicam	Aunt	March 28, 2014	17-year-old nephew	Ewing's Sarcoma, bone pain and 10 cm protuberance, fainting, weight-loss, lack of appetite	Aerial spraying, being sprayed by planes while playing outside, exposure to burning of insecticide containers nearby	Doctor	Not specified	Passed away after being interned and receiving radiation treatments
Lucia Hernandez, female, and Hermenejildo Sibamea, male	Cocorit	Community Healers	January 2014	Baby girl in community	Birth defects, baby's body was amorphous and gelatinous	Parents' work with pesticides, arsenic in water	Healers giving testimony	Not specified	Passed away 4 h after birth
Maria de Jesus Valenzuela	Not specified	Mother	January 20, 2014	10-year-old child	Myringitis, mild kidney problem, loss of speech, weakening of body, needs wheelchair	Aerial spraying	Not specified	Not specified	No
Ambrocio Matuz, male	Vicam	Former Governor of Vicam Pueblo	August 5, 2009	Child named Ramon Valenzuela Elenes	Leukemia	Child's home was 50 meters from an agricultural field sprayed with pesticides	Doctor	Not specified	Passed away from leukemia

Table 1 (Continued)

Name of Community Member, age, gender (if provided)	Yaqui Pueblo	Role in Community	Date Collected	Affected Individuals	Health Issues or symptoms described	Pesticide transmission	Medical Specialists Seen	Medical specialist opinion	Mortality
Javier Villegas Paredes	Not specified	Agricultural Parasitologist	November 20, 2005	Rigoberto Cota Amarillas, 6-year-old child, male	Leukemia, high temperature, vomiting, loss of appetite	Local spraying, playing with agricultural machinery kept at home, and exposure to aerial spraying	Doctor	Doctor attributed the diagnosis to the child's contact with the chemicals and the local spraying	Passed away at the age of 6 from pesticide poisoning
Ofelia Seguapicio, Jesus Gonzalez, Aurelia Espinoza, Lina Molina and Teofil Mendoza	Not specified	Town doctors/ midwives	December 2011	Newborn babies	Leukemia, cancer, birth defects	Agrochemicals in drinking water	Doctors	Testifying doctors considered the illnesses to be a result of water contaminated with agrochemicals	Not specified

Table 1: Yaqui pesticide testimony breakdown.

?

Pesticide	Cord Blood (ppm)	Milk (ppm corrected for fat)
N	19	20
a-HCH	0.030 ± 0.03	0.8599 ± 2.75
b-HCH	0	0.3791 ± 1.08
Lindane	0.084 ± 0.06	0.6710 ± 0.59*
D-HCH	0.0039 ± 0.1	0.4432 ± 0.84
Heptachlor	0	1.269 ± 1.65*
BHC	0.003 ± 0.002	0.6270 ± 0.66*
Aldrin	0	0.2363 ± 0.59*
Dieldrin	0.159 ± 0.12	0.0487 ± 0.08
Endrin	0.022 ± 0.02	0.5238 ± 1.1*
p,p'-DDE	0.03 ± 0.03	6.31 ± 5.9

Table 2: Pesticide compounds found in the cord blood and breast milk of Yaqui newborns and their mothers by part per million (ppm). *Represents an amount that exceeds World Health Organization (WHO) established limits.
 Full names of abbreviated pesticides in chart order: α-Hexachlorocyclohexane (a-HCH), β-Hexachlorocyclohexane (b-HCH), delta-Hexachlorocyclohexane (D-HCH), beta-Hexachlorocyclohexane (BHC), Dichlorodiphenyldichloroethylene (p,p'-DDE).

towards the export of products prohibited from domestic sale prioritizes profit and does not take into account whether the importing country has sufficient protections for inhabitants exposed to these chemicals.³³

In order for a U.S. company to export a domestically banned chemical, importing countries are required to legally acknowledge the risks involved by signing a [foreign purchaser acknowledgement statement \(FPAS\)](#). Currently, there are minimal processes within FIFRA that compel importing countries of pesticides to set concrete human rights standards around the use of pesticides or to compel the U.S. to limit exportation of domestically banned pesticides to only countries that meet strict human rights standards. While the U.S. is required to inform countries when a pesticide is not registered in the U.S. and why, there is no assurance that Indigenous Peoples will be asked for their consent, made aware of the risks, or provided proper personal protection when using banned pesticides. A 2008 study by Madrid et al. detected residues on prickly pear vegetables from six commercial orchards in Sonora, Mexico from two imported pesticides not authorized for vegetable use in Mexico: chlorpyrifos and methyl parathion.³⁴ Thus, the burden of regulatory precautions disproportionately falls on LMICs where regulations are less strict and an overwhelming number of pesticide-related maladies occur.^{28,35} Additionally, once the pesticides are sold, there are no processes that give a voice to Indigenous Peoples or racial and ethnic minorities to prevent the harmful side effects which were the justification for banning these substances in the U.S. in the first place.

Rotterdam Convention: The Rotterdam Convention is a UN chemical treaty to which the U.S. is a signatory. Like FIFRA in the U.S., the Convention permits the export of banned pesticides if the importing country is notified the chemical is domestically unregistered or banned. The need for action to revise the UN Rotterdam Convention was included in the final report of the 13th

session of the UN Permanent Forum on Indigenous Issues (UNPFII) which stated: “Considering their impact on the sexual health and reproductive rights of Indigenous Peoples, the Permanent Forum calls for a legal review of the United Nations chemical conventions, in particular the Rotterdam Convention, to ensure that they are in conformity with international human rights standards, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and the Convention on the Rights of Persons with Disabilities.”³⁶

Yaqui leaders taking action

Yaqui advocacy around banned pesticides has leaned heavily on Article 29, 24 and 22 of the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), endorsed by almost every member country of the UN, including the U.S. and Mexico. These articles emphasize that Indigenous Peoples have the rights to protection from hazardous materials, involvement in policy formation on issues that impact them, physical health, and protection against all forms of violence and discrimination.^{37,38} The UN Convention on the Rights of a Child (CRC), which the U.S. has not ratified, and the UN Committee on the Elimination of Racial Discrimination, also contain standards that Yaqui leaders have utilized to protect their rights to health.³⁹⁻⁴¹

In 2006, Yaqui Traditional Authorities in Mexico presented a Declaration banning aerial spraying of banned pesticides in Yaqui lands. The concerns of the Yaqui government were submitted to the UN Committee on the Elimination of Racial Discrimination (CERD). In February 2008, the CERD called upon the U.S. to take appropriate legislative and administrative measures to prevent transnationals it registers “from negatively impacting on the enjoyment of rights of Indigenous peoples in territories outside the U.S.”⁴⁰

Although the CERD asked the U.S. to change their pesticide policies with a direct reference to their negative impacts on Indigenous Peoples, FIFRA still allows U.S. companies to export banned and restricted pesticides to other countries.

Similar reports were also brought to the UN Convention on the Rights of the Child (CRC), a legally binding international treaty which protects children's rights to health and compels countries to combat diseases, malnutrition, provide clean drinking water, and take into consideration the dangers of environmental pollutants and toxic exposures.⁴¹

As of 2010, Mexican pesticide policies made no mention of children, or provisions to protect fetuses and pregnant mothers.⁴² Between 2011 and 2015, Mexico had the second highest number of human pesticide poisoning cases in Latin America.⁴³

In its official country review of Mexico in 2015, under the heading "Environmental Health", the CRC expressed concerns "that the State party has not taken sufficient measures to address air, water, soil and electromagnetic pollution, which gravely impact on children and maternal health. The import and use of pesticides or chemicals banned or restricted for use in LMICs, which particularly affect Indigenous children in the state of Sonora, is also a reason of deep concern." The Committee specifically recommended that Mexico "prohibit the import and use of any pesticides or chemicals that have been banned or restricted for use in exporting countries."⁴⁴

In April 2018, the UN Special Rapporteur on Toxics shared preliminary observations at the UN Permanent Forum on Indigenous Issues' (UNPFII) 17th session, emphasizing that "Indigenous peoples such as the Yaqui have suffered grave adverse impacts on their health and dignity from the ongoing use of highly hazardous pesticides. These pesticides are often imported from countries that have banned their use domestically because of uncontrollable and unreasonable risks."⁴⁵

In response, Mexico has begun to take official steps to halt the importation of banned U.S. pesticides and pesticides that are known to cause severe health impacts. In 2019, Víctor Toledo Manzur, Mexican Secretary of Environment and Natural Resources, announced Mexico's plan to prohibit import of banned and dangerous pesticides.⁴⁶ Although Mexico is on track to eliminate the use of one harmful chemical (glyphosate) by 2024, it still authorizes other highly toxic pesticides, including paraquat and dicamba, which are banned in most other countries. Mexico still authorizes more than 3,000 insecticides, herbicides, and fungicides for agricultural, forestry, domestic, gardening, urban, and industrial uses.⁴⁷ Among them are at least 180 active substances classified as highly toxic in international agreements, including the Rotterdam Convention, and 111 which are prohibited in other countries including the European Union.⁴⁸

A moral obligation for policy change

Unquestionably, the moral obligation of the U.S. to institute a uniform pesticide export policy should stem from general principles of fairness and human decency. There is little justification for allowing other countries to use chemicals that we created but will not use ourselves because we know are harmful. Some countries may be able to recognize and exclude banned chemicals from importation, while others lack the necessary legal infrastructure, fiscal morality, human rights priorities, or political will to handle them responsibly and ensure marginalized communities are protected.⁴⁹ The U.S. can set a standard of global health leadership by recognizing that FIFRA is morally flawed, and taking a legal stance that U.S.-affiliated chemical corporations should never profit from another country's chemical negligence at the expense of human life.

On the U.S. front, pesticide laws should follow science, respect human rights, and withstand political change. Assuming U.S. citizens are protected by simply banning dangerous pesticides domestically does not follow scientific logic nor respect human rights. Even if the U.S. successfully banned every harmful pesticide and strictly regulated their uses domestically, pesticides do not respect borders. Pesticides banned for U.S. citizens that are sprayed on imported international crops can remain on food as residue and end up in U.S. grocery stores.^{28,48} In 2019, samples from potatoes, squash, and chiles grown in the Yaqui and Mayo valleys contained residues of pesticides that have been banned for use, although in quantities that did not surpass maximal limits for consumption.⁵¹ Regarding other crops coming specifically from Yaqui territory in Sonora, Mexico, and other places around the world where banned pesticides are used, further toxicological studies should be done to fully understand consumer risk.⁸ Thus, sending harmful pesticides elsewhere internationally can not only harm individuals in those countries, but also puts U.S. citizens at currently unknown risk.^{28,50}

As a member of UN international organizations such as the UN Food and Agricultural Organization (FAO) and the WHO, the U.S. and Mexico have supported an international policy which seeks "to protect the health of consumers and to ensure fair practice in the trade, [and] to promote coordination of all food standards." At the global level, there is solid scientific evidence to establish or strengthen international, legally binding pesticide policies like the UN Rotterdam Convention to require importing and exporting countries to protect the rights of everyone, including Indigenous Peoples. We believe this global framework should go as far as to make it illegal for any company to export a pesticide or chemical that has been banned for domestic use due to its known detrimental health impacts.

It is clear the continued trade of banned pesticides disproportionately impacts Indigenous Peoples such as Yaqui Nation. Like other forms of systemic racism that

impact health, tackling environmental violence requires system-level solutions, concrete policy change, and more attention from the global medical community. Thus, we propose the following five U.S. and UN policy actions and two recommendations to the global medical community to reduce environmental violence:

- (1) Align global pesticide trade policies to the minimum-standards within the UNDRIP to ensure Indigenous rights to involvement in policy formation on issues that impact them, and protection against all forms of anti-Indigenous racism, including environmental violence.
- (2) Amend the UN Rotterdam Convention to prohibit countries from exporting pesticides that they have banned domestically due to their known detrimental environmental and human health impacts
- (3) Amend FIFRA to make the international export of domestically banned pesticides illegal in the U.S.
- (4) Establish or strengthen UN and U.S. policies to ensure chemical companies properly label all pesticide products so buyers and users throughout the entire supply chain are aware of the risks involved and proper safety protocols for their uses.
- (5) Establish or strengthen UN and U.S. policies to ensure proper training and personal protective precautions for global workers with occupational exposure to pesticides.
- (6) The global medical community should align their advocacy for Indigenous health to the UN Declaration on the Rights of Indigenous Peoples (UNDRIP).
- (7) The global medical community should prioritize more academic resources toward further study, understanding, and prevention of environmental violence, in all its forms, against Indigenous Peoples and other marginalized communities.

Environmental violence from banned pesticides is well-documented, and the time for action is now. Protecting humans from dangerous chemicals should not be defined by borders, profit, or political party lines. If a pesticide is found to be unsafe for humans in the U.S., then it is unsafe for humans anywhere.

Contributors

Victor A. Lopez-Carmen: Lead Author, created the concept for the manuscript, writing, translation, interpretation, literature search, revisions.

Timothy B. Erickson: Writing authorship, literature review, data interpretation, toxicological expertise, mentorship of junior authors, revisions

Zara Escobar: Writing authorship, data interpretation, compiled main tables, revisions

Anpotowin Jensen: Writing authorship, data interpretation, literature review, revisions

Alexandria E. Cronin: Literature review

LaShyra T. Nolen: Writing authorship, critical race-theory concept development, revisions

Marcos Moreno: Writing authorship, provided cultural and academic expertise on the Pascua Yaqui Tribe, revisions

Amanda M. Stewart: Senior author, mentorship, writing, literature review, data interpretation, advocacy/government relations expertise, revisions

Declaration of interests

No interests to declare.

Acknowledgements

The authors would like to thank all the Indigenous Peoples, Indigenous Nations, Indigenous Organizations, and allies who have and continue to advocate for justice on this issue. The authors would also like to thank Miriam Singer, Ayotomiwa Ojo and their team, who created permanent required curricula at Harvard Medical School on the impacts of banned pesticides on the reproductive health of Yaqui women.

Funding

This research did not receive any specific grant funding agencies in the public, commercial, or non-for-profit sectors.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.lana.2022.100255](https://doi.org/10.1016/j.lana.2022.100255).

References

- 1 Smith C, Kerr K, Sadripour A. Pesticide exports from U.S. ports, 2001–2003. *Int J Occup Environ Health*. 2008;14:176–186.
- 2 Donley N. The USA lags behind other agricultural nations in banning harmful pesticides. *Environ Health*. 2019;18(1):44. A Global Access Science SourceJun 7.
- 3 Atwood D, Paisley-Jones C, United States Environmental Protection Agency. *Pesticides Industry Sales and Usage 2008–2012*. United States Environmental Protection Agency; 2017. [Internet][cited 2022 Mar 22]. Available from: https://www.epa.gov/sites/default/files/2017-01/documents/pesticides-industry-sales-usage-2016_o.pdf.
- 4 Navarro-Espinoza S, Angulo-Molina A, Meza-Figueroa D, et al. Effects of untreated drinking water at three indigenous Yaqui towns in Mexico: insights from a murine model. *Int J Environ Res Public Health*. 2021;18(2):305.
- 5 Moreno-Villa ED, Aldana-Madrid ML, Silveira-Gramont ML, Rodríguez-Olibarría G, Valenzuela-Quintanar AI, Meza-Montenegro M. Analysis of pyrethroids in soil and water in agricultural areas and urban valleys Yaqui and Mayo. *Rev Int Contam Ambient*. 2012;28(4).
- 6 Carmen A, Waghyyi V. Indigenous women and environmental violence: a rights-based approach addressing impacts of environmental contamination on indigenous women, girls and future

- generations. Submitted to the United Nations Permanent Forum on Indigenous Issues Expert Group Meeting “Combating Violence Against Indigenous Women and Girls”; 2012. [cited 2022 Jan 13]. Available from: https://www.un.org/esa/socdev/unpfii/documents/EGM12_carmen_waghiyi.pdf.
- 7 Columbia Law School. *Kimberlé Crenshaw on Intersectionality, More than Two Decades Later*. Columbia Law School; 2017. [Internet] [cited 2022 Jan 13]. Available from: <https://www.law.columbia.edu/news/archive/kimberle-crenshaw-intersectionality-more-two-decades-later>.
 - 8 Aldana-Madrid ML, Valdez-Hurtado S, Vargas-Valdez ND, et al. Insecticide residues in stored grains in Sonora, Mexico: quantification and toxicity testing. *Bull Environ Contam Toxicol*. 2008;80(2):93–96.
 - 9 Limon-Miro AT, Aldana-Madrid ML, Alvarez-Hernandez G, Antunez-Roman LE, Rodriguez-Olibarria G, Valencia Juillerat ME. Breast milk intake and mother to infant pesticide transfer measured by deuterium oxide dilution in agricultural and urban areas of Mexico. *Chemosphere*. 2017;181:682–689.
 - 10 Limon-Miro A, Aldana-Madrid M, Antunez-Roman L, Alvarez-Hernandez G, Rodriguez-Olibarria G, Valencia M. Human milk intake and pesticide transfer in agricultural and Urban Areas of Sonora, Mexico. *FASEB J*. 2015;29(S1).
 - 11 Alegria-Torres J, Baccarelli A. Collaboration between centres of the World Health Organization. Italy supports a Mexican University. *Med Lav*. 2010;101(6):453–457.
 - 12 Pesticide Action Network Germany. *Pesticides and Health Hazards: Facts and Figures*. Pesticide Action Network Germany; 2012. [Internet] [cited 2022 Jan 13]. Available from: <https://www.panna.org/sites/default/files/Pesticides%20and%20Health%20Harms-%20PAN%20G%202012.pdf>.
 - 13 Meza-Montenegro MM, Valenzuela-Quintanar AI, Balderas-Cortés JJ, et al. Exposure assessment of organochlorine pesticides, arsenic, and lead in children from the major agricultural areas in Sonora, Mexico. *Arch Environ Contam Toxicol*. 2013;64(3):519–527.
 - 14 Pesticide Action Network International. *PAN International Consolidated List of Banned Pesticides*. Pesticide Action Network International; 2021. [Internet] [cited 2022 Jan 13]. Available from: <https://pan-international.org/pan-international-consolidated-list-of-banned%20-pesticides/>.
 - 15 United States Environmental Protection Agency. *International Activities Related to Pesticides*. United States Environmental Protection Agency; 2022. [Internet] [cited Jan 13]. Available from: <https://www.epa.gov/pesticides/international-activities-related-pesticide-#import>.
 - 16 Buffington E, McDonald S, Colorado Environmental Pesticide Education Program. *Banned and Severely Restricted Pesticides*. Colorado Environmental Pesticide Education Program; 2006. [Internet] [cited 2022 Jan 13]. Available from: <https://webdoc.agsci.colostate.edu/cepep/FactSheets/14BannedPesticides.pdf>.
 - 17 Petition to Revoke Food Tolerances and Cancel Registrations for Harmful Organophosphate Uses. United Farm Workers, United Farm Workers Foundation, Earthjustice; 2021 [cited 2022Jan13]. Available from: https://earthjustice.org/sites/default/files/files/2021.11.18_op_petition_-_final.pdf.
 - 18 Fernandez-Cornejo J, Nehring R, Osteen C, Wechsler S, Martin A, Vialou A. Pesticide use in U.S. agriculture: 21 selected crops, 1960–2008. In: *Agricultural Pesticides: Usage Trends and Analysis of Data Sources*. United States Department of Agriculture (USDA); 2011.
 - 19 Gunnell D, Knipe D, sen CS, et al. Prevention of suicide with regulations aimed at restricting access to highly hazardous pesticides: a systematic review of the international evidence. *Lancet Glob Health*. 2017;5(10):1026–1037.
 - 20 Silveira-Gramont MI, Aldana-Madrid ML, Piri-Santana J, Valenzuela-Quintanar AI, Jasa-Silveira G, Rodriguez-Olibarria G. Agricultural pesticides: a reference framework to evaluate risk to health in rural communities in the State of Sonora, Mexico. *Rev Int Contam Ambient*. 2018;34(1):7–21.
 - 21 Valenzuela A, Gutiérrez L, Camarena B, et al. Levels of organochlorine pesticides in soils of the major agricultural zones in Sonora, Mexico and the implementation of a communication strategy for the risk exposure prevention. *Toxicol Lett*. 2016;259:S223.
 - 22 López-Gálvez N, Wagoner R, Beamer P, de Zapien J, Rosales C. Migrant farmworkers’ exposure to pesticides in Sonora, Mexico. *Int J Environ Res Public Health*. 2018;15(12):2651.
 - 23 Cantu-Soto EU, Meza-Montenegro MM, Valenzuela-Quintanar AI, et al. Residues of organochlorine pesticides in soils from the southern Sonora, Mexico. *Bull Environ Contam Toxicol*. 2011;87(5):556–560.
 - 24 García De Llasera MP, Bernal-González M. Presence of carbamate pesticides in environmental waters from the northwest of Mexico: determination by liquid chromatography. *Water Res*. 2001;35(8):1933–1940.
 - 25 García-Hernández J, Leyva-Morales JB, Bastidas-Bastidas P de J, et al. A comparison of pesticide residues in soils from two highly technified agricultural valleys in northwestern Mexico. *J Environ Sci Health Part B Pestic Food Contam Agric Wastes*. 2021;56(6):548–565.
 - 26 CONSIDERATION OF THE FOURTH AND FIFTH PERIODIC REPORTS OF MEXICO UNDER ARTICLE 44 OF THE UNITED NATIONS CONVENTION ON THE RIGHTS OF THE CHILD, INDIGENOUS PEOPLES ALTERNATIVE REPORT. International Indian Treaty Council; 2015 [cited 2022 Jan 13]. Available from: https://www.iitc.org/wp-content/uploads/IndigenousAlternativeReport-CRC-Mexico-2015_web.pdf.
 - 27 Loreto-Gómez C, Fariás P, Moreno-Macías H, Guzmán C, Riojas-Rodríguez H. Prenatal exposure to persistent organic compounds and their association with anogenital distance in infants. *Reprod Biomed*. 2018;37(6):732–740. <https://doi.org/10.1007/s11356-019-07087-6>. Online In press.
 - 28 Balderrama-Carmona AP, Valenzuela-Rincón M, Zamora-Álvarez LA, et al. Herbicide biomonitoring in agricultural workers in Valle del Mayo, Sonora Mexico. *Environ Sci Pollut Res*. 2020;27(23):28480–28489.
 - 29 McLaughlin E. [Internet]. Export of Banned US Pesticides Creates a Deadly Circle of Poison. Truthout; 2019 [cited 2022 Jan 13]. Available from: <https://truthout.org/articles/export-of-banned-us-pesticides-creates-a-deadly-circle-of-poison/>.
 - 30 Guillette EA, Meza MM, Aquilar MG, Soto AD, García IE. An anthropological approach to the evaluation of preschool children exposed to pesticides in Mexico. *Environ Health Perspect*. 1998;106(6):347–353.
 - 31 Guillette EA, Conard C, Lares F, Aguilar MG, McLachlan J, Guillette LJ. Altered breast development in young girls from an agricultural environment. *Environ Health Perspect*. 2006;114(3):471–475.
 - 32 Gómez-Arroyo S, Martínez-Valenzuela C, Calvo-González S, et al. Assessing the genotoxic risk for Mexican children who are in residential proximity to agricultural areas with intense aerial pesticide applications. *Rev Int Contam Ambient*. 2013;29(3):217–225.
 - 33 United States Environmental Protection Agency. *Summary of the Federal Insecticide, Fungicide, and Rodenticide Act*. United States Environmental Protection Agency; 1996. [Internet] [cited 2022 Jan 13]. Available from: <https://www.epa.gov/laws-regulations/summary-federal-insecticide-fungicide-and-rodenticide-act>.
 - 34 Seferovich PB. United States export of banned products: legal and moral united states export of banned products: legal and moral implications implications. *Denver J Int Law Policy*. 1981;10:537–560.
 - 35 Aldana Madrid ML, García Moraga MDC, Rodríguez Olibarria G, Silveira Gramont MI, Valenzuela Quintanar AI. Determination of organophosphate insecticides in fresh and dried prickly pear cactus pads. *Rev Fitotec Mex*. 2008;31(2):133–139.
 - 36 Schreinemachers P, Tipraqsa P. Agricultural pesticides and land use intensification in high, middle and low income countries. *Food Policy*. 2012;37(6):616–626.
 - 37 UN Permanent Forum on Indigenous Issues. Recommendations on Health. [cited 2022Jan13]. Available from: <https://www.un.org/development/desa/indigenouspeoples/mandated-areas1/health/recs-health.html>; <https://www.un.org/development/desa/indigenouspeoples/mandated-areas1/health/recs-health.html>.
 - 38 United Nations For Indigenous Peoples, United Nations declaration on the rights of indigenous peoples [Internet]. [cited 2022 Jan 13]. Available from: <https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html>.
 - 39 Hopkins J. Submission to the committee on the elimination of racial discrimination by the traditional authorities of the rio yaqui pueblos [Internet]. COMMITTEE ON THE ELIMINATION OF RACIAL DISCRIMINATION. 2012 [cited 2022 Jan 13]. Available from: https://tbinternet.ohchr.org/Treaties/CERD/Shared%20Documents/MEX/INT_CERD_NGO_MEX_80_9637_E.pdf.
 - 40 Global Initiative for Economic, Social and Cultural Rights. Parallel Report submitted by the global initiative for economic, social and cultural rights to the human rights committee on the occasion of the consideration of the Fourth Periodic Report of the United States during the Committee’s 109th Session. UN Human Rights Council 2013. [cited 2022 Jan 13]. Available from: <https://>

- tbinternet.ohchr.org/Treaties/CCPR/Shared%20Documents/USA/INT_CCPR_CSS_USA_16633_E.pdf.
- 41 United Nations Human Rights Office of the High Commissioner. Convention on the Rights of the Child 1989. [cited 2022 Jan 13]. Available from: <https://www.ohchr.org/EN/professionalinterest/pages/crc.aspx>.
- 42 Cifuentes E, Trasande L, Ramirez M, Landrigan PJ. A qualitative analysis of environmental policy and children's health in Mexico. *Environ Health*. 2010;9(1):14. A Global Access Science Source.
- 43 Boedeker W, Watts M, Clausing P, Marquez E. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. *BMC Public Health*. 2020;20(1):1943.
- 44 United Nations Committee on the Rights of the Child. *Concluding Observations on the Combined Fourth and Fifth Periodic Reports of Mexico*. United Nations Committee on the Rights of the Child; 2015. [Internet][cited 2022 Jan 13]. Available from: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/G15/146/11/PDF/G1514611.pdf?OpenElement>.
- 45 Yucupicio P. International Indian Treaty Council Statement. United Nations Permanent Forum on Indigenous Issues 18th session 2019. [cited 2022 Jan 13]. Available from: <https://www.iitc.org/wp-content/uploads/UNPFII-on-Indigenous-Issues-18th-Session-Follow-up-on-Recommendations-Item-3-1.pdf>.
- 46 Secretaría de Medio Ambiente y Recursos Naturales. Estudios científicos demuestran los daños del plaguicida a organismos vivos y al ambiente, incluyendo polinizadores 2019. [cited 2022 Jan 13]. Available from: <https://www.gob.mx/semarnat/prensa/niega-semarnat-importacion-de-mil-toneladas-de-glifosato-bajo-el-principio-precautorio-para-la-prevencion-de-riesgos?idiom=es>.
- 47 Godoy E. Mexico bans glyphosate but tolerates other agrochemicals 2021. North American Conference on Latin America. [cited 2022 Jan 13]. Available from: <https://nacla.org/mexico-amlo-glyphosate-pesticides>.
- 48 Hernández-Antonio A, Hansen AM. Uso de plaguicidas en dos zonas agrícolas de México y evaluación de la contaminación de agua y sedimentos. *Rev Int Contam Ambient*. 2011;27(2):115-127.
- 49 Mayett-Moreno Y, Oglesby JML. Beyond food security: challenges in food safety policies and governance along a heterogeneous agri-food chain and its effects on health measures and sustainable development in Mexico. *Sustainability*. 2018;10(12):4755. (Switzerland).
- 50 Al Jazeera. *The Big 6 And The Circle Of Poison*. Al Jazeera; 2022. [Internet][cited Jan 13]. Available from: <https://www.aljazeera.com/news/2016/12/6/the-big-6-and-the-circle-of-poison>.
- 51 Cantú Nava PC, Meza Montenegro MM, Valenzuela Quintanar AI, et al. Determinación de plaguicidas organoclorados en hortalizas del sur de Sonora: calidad y seguridad de los alimentos en relación a los límites máximos permitidos. *Biotecnía*. 2019;21(2):19-27.