Fact Sheet

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BURNING AGRICULTURAL WASTE: A SOURCE OF DIOXINS

Background

Since 1994, Canada, Mexico and the United States have been cooperating on environmental matters of mutual concern through the Commission for Environmental Cooperation (CEC).[1] In 2000, the CEC's Sound Management of Chemicals (SMOC) Working Group established a task force on dioxins, furans and hexachlorobenzene, which had the mandate to develop and implement strategies for facilitating the effective management of chemicals in the region. One of its objectives has been to help Mexico develop public information materials that can provide the foundation for decision-making. This document is part of that effort. It is designed for the interested public and contains information that may be useful for decision-makers.

Burning Agricultural Waste

In many countries, burning agricultural waste, such as stalks, grasses, leaves and husks, continues to be the easiest and least expensive way to reduce or eliminate the volume of combustible materials produced by agricultural activities. Open-air burning is used to eliminate waste from the previous harvest in the quickest manner, and to clear fields to prepare them for planting. It is also used to release nutrients for the following growing season and to eliminate mosquitoes and other pests in crop-growing fields. Sugar cane fields are burned prior to harvesting to remove excess leaves and thus facilitate the harvesting and transporting of products to sugar refineries. It is also believed that burning the sugar cane fields reduces the risk of insect bites and cuts for workers.

It is estimated that burning biomass, such as wood, leaves, trees and grasses—including agricultural waste—produces 40% of carbon dioxide (CO_2), 32% of carbon monoxide (CO), 20% of particulate matter (PM), and 50% of polycyclic aromatic hydrocarbons (PAHs) released into the environment around the globe.[2] Although agricultural waste burning is not an environmentally acceptable form of agricultural management, it is a frequent practice and is worrisome from a public health viewpoint for a number of reasons:[3]

- Smoke from agricultural burning is released at or near ground level in areas that are generally populated, producing direct, intense exposure to pollutants for the nearby populations.
- This type of burning is generally carried out in stages, during specific times of the year, and may lead to very high concentrations of pollutants.
- Burning agricultural waste creates non-specific sources of pollutants for the atmosphere and takes place over very large areas. It is therefore difficult to measure and to regulate the resulting emissions.
- Combustibles and combustion conditions vary, and pesticides may be present.
- This type of burning contributes to climate change, since among the compounds released are greenhouse gases and short-lived climate-forcing pollutants like black carbon.
- Visibility in nearby areas and highways is affected.
- In addition, these incomplete combustion processes produce dioxins, which are highly toxic, carcinogenic pollutants.

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[1] See <www.cec.org>.

[2] A.D. Kambis and J.S. Levine. 1996. Biomass burning and the production of carbon dioxide: a numerical study. Chapter 17 in: *Biomass Burning and Global Change*, Joel S. Levine (comp.) 1: 170-177, Massachusetts Institute of Technology, Cambridge, MA (US).

[3] P.M. Lemieux, C.C. Lutes and D.A. Santoianni. 2004. Emissions of organic air toxics from open burning: a comprehensive review. *Progress in Energy and Combustion Science* 30: 1-32.

Agricultural Waste Burning Is a Significant Source Of Dioxins

Biomass burning as an agricultural practice is considered to be a significant source of dioxins. The factors that play a part in the emission of dioxins are the combustion conditions, chlorine content, and presence of pesticides absorbed into the leaves and stalks of agricultural waste.

It has been found in Taiwan, for example, that during the week of the most intense agricultural burning, the concentration of dioxins in the atmosphere is up to 17 times higher than in weeks when such burning is absent.[4] In China, larger amounts of dioxins are emitted in the provinces with more agricultural production—constituting between 10 and 20% of total emissions of dioxins[5]—than in provinces with less agricultural production. Results of studies indicate that dioxins can be formed during the combustion process due to the presence of chlorinated pesticides, such as pentachlorophenol (PCP) fungicide and the herbicide known as 2,4-dichlorophenoxyacetic acid (2,4-D). It has been demonstrated, for example, that dioxin emissions increase by 150 times when biomass treated with 2,4-D is burned.[6] Also, dioxins released to the soil through ash increase when agricultural waste contaminated with pesticides are burned. For example, dioxin emissions are between 35 and 270 times greater in the case of corn stalks treated with pesticides, compared to the amount of dioxins released when such waste has not been so treated.[7]

Dioxins and Their Toxicity

It is believed that even in very small amounts, dioxins constitute a health and environmental problem since they:

- Are persistent and remain in the environment for long periods of time before degrading into other chemical forms.
- Accumulate and are stored in the fatty tissue of animals and humans.
- Are able to be transported long distances in the atmosphere, and are thus sometimes generated in one area but ultimately can be found in another region far away.

Numerous studies link exposure to dioxins with a variety of harmful effects on health, such as:

- Lower sperm concentration in males who were exposed when they were infants or children.
- Changes in thyroid hormone levels.
- Neurological effects in the fetus due to exposure during pregnancy.
- Lower testosterone levels.
- Reproductive problems in women, such as prolonged menstruation and early menopause.
- Diabetes and harmful effects to the immune system.
- Chloracne, which can be severe when exposure is very high.
- Various types of cancer in humans.

Harmful Effects to Health Caused by Emissions from Agricultural Burning

Pollutants emitted from agricultural burning, such as polycyclic aromatic hydrocarbons and very small particulates ($PM_{2.5}$), can cause cancer in humans as well as severe respiratory illnesses, coughing, phlegm and asthma. For example, during the season in which sugar cane is burned, an increase in asthma attacks

[4] S. Shih, W. Lee, L. Lin, J. Huang, J. Su, and G. Chien. 2008. Significance of biomass open burning on the levels of the polychlorinated dibenzo-p-dioxins and dibenzofurans in the ambient air. *Journal of Hazardous Materials* 153: 276-84.
[5] Q. Zhang, J. Huang and G. Yu. 2008. Polychlorintaed dibenzo-p-dioxins and dibenzofurans emissions from open burning of crop residues in China between and 2004. *Environmental Pollution* 151: 39-46.
[6] M. Muñoz, B.K. Gullet, A. Touati, R. Font. 2012. Effect of 2,4-dichlorophenoxyacetic acid (2,4-D) on PCDD/F emissions from open burning of biomass. *Environmental Science & Technology* 46: 9308-14.
[7] T. Zhang, J. Huang and G. Yu. 2011. Influence of pesticides contamination on the emission of PCDD/PCDF to the land from open burning of corn straws. *Environmental Pollution* 159(6): 1744-48.

has been observed in the population living near sugar cane fields in southern Louisiana in the United States. In fact, hospital admissions due to various respiratory problems increase by 50% during this time of year.[8] In Brazil, the world's largest sugar cane producer, elevated PM levels have also been observed, as well as an increase in respiratory problems, during the season when sugar cane is burned.[9]

Agricultural Burning and the Burning of Agricultural Waste in Mexico

According to an inventory of dioxins and furans,[10] agricultural waste burning ranks third among the sources of dioxin emissions in Mexico. In the document cited, this source is identified as less serious than only two other diffuse sources: uncontrolled household trash burning and fires in sanitary landfills. The yearly emissions of dioxins and furans from agricultural burning in Mexico are estimated at 750.34 g i-TEQ_{DF}.[11]

In Mexico there is a widely held traditional practice of agricultural burning aimed at eliminating undesired waste after harvesting grains, such as rice, corn and wheat, and beans. It is also common to burn branches and weeds from fruit and walnut tree orchards and vineyards, and also poultry and livestock manure. Unfortunately, we find that plastic gunny sacks and other plastic materials used in greenhouses and ditches are also burned, as well as empty bags from insecticides and fertilizers, and paper and plastic materials used for protecting workers (used, for example, in banana and date fields), plus drying racks and other materials—combined with waste from harvested crops, contributing even more contamination.

"Slash and burn" agriculture has traditionally been used in Mexico for the purpose of rapidly incorporating certain nutrients into the soil, getting rid of weeds and eradicating pests. Nevertheless, this practice is highly contaminating and if adequate precautions are not taken, small, untended fires get out of control and become huge fires. Also, the use of fire in preparing agricultural fields has its consequences, including soil erosion, loss of nutrients and, in the long term, reduced productivity. When burning is first used, this practice appears to help promote new growth, but a decrease in fertility will be noted over the long term, together with deterioration of the plant cover and a loss of soil moisture. All of this translates into reduced crop yields and the eradication of beneficial microorganisms and insects.[12]

Sometimes agricultural burning is considered to be necessary, for example, in order to prevent the spreading of certain pests.[13] Other reasons are economic in nature, since if the straw left behind from harvesting is burned, costs can be reduced by not using machinery and diesel fuel, as it will not be necessary to incorporate the straw into the soil with a disc plough. Burning waste after harvest also saves time in preparing the soil for the next planting. However, over the long term, deterioration of plant cover and a diminishing of soil quality are inevitable.

Controls and Alternatives to Agricultural Waste Burning

- It is possible to decrease emissions by establishing a controlled, phased program for burning, designed to produce less smoke in a determined period of time. It is also important to assure that waste is as dry as possible before burning.

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[8] Raj Boopathy et al. 2002. Sugar cane (*Saccharum officinarum*) burning and asthma in southeast Louisiana, USA. *Bulletin of Environmental Contamination and Toxicology* 68: 173-79.
[9] See <www.burningissues.org>.
[10] Pablo Maíz Larralde. 2010. Mexico 2004 PCDD/F National Releases Inventory Revision: recent studies on quantification of emissions from specific sources. In: *Fourth Workshop on Sources and Measurements of Dioxins, Furans and HCB,* Commission for Environmental Cooperation, Mexico City, November 2010. <www.cec.org/Storage.asp?StorageID=4098>.
[11] International Toxic Equivalents (i-TEQs) for dioxins and furans (DF).
[12] United Nations Food and Agriculture Organization (FAO). Transición de la quema a la práctica de no quema, at: <www.fao.org/climatechange/34147-0513b607625cf6b489b18b544c3452038.pdf>.
[13] M. Quintero Núñez and A. Moncada Aguilas. 2008. Contaminación y control de las quemas agrícolas en Imperial, California y Mexicali, Baja California, *Región y Sociedad* 43(XX): 3-24.

- Collection of waste and its reuse for:
    - Fuels, such as ethanol and biogas (methane)
    - Compost production
    - Animal feed
    - Construction materials (adobe blocks made with straw, an excellent thermal insulator)
    - Growing mushrooms and other crops
    - Beds for stables (more information: <www.arb.ca.gov/smp/biomass/biomass.htm>)

- Reincorporation into cropland to increase soil fertility and improve its organic composition. It may be difficult at first, but in the long term, the agricultural characteristics of the soil will be improved. The advantage of using "stubble cultivation" is to spread out more than 50% of the waste (leaves, stalks and brush) from the previous harvest in the land plot, and in this way: reduce the use of agrochemicals, conserve soil moisture, diminish erosion and reduce the risk of fires. For more information regarding sustainable agriculture and stubble cultivation, see <www.inca.gob.mx/videoteca/> and <www.sagarpa.gob.mx/desarrolloRural/Documents/cambioclimatico/Tecnologias_mitigacion.pdf>.

- There are Mexican states in which, due to air quality problems, the burning of agricultural waste has been prohibited. In the state of Guanajuato, for example, a program has been implemented to provide agricultural producers with machinery for harvesting and reusing waste as livestock feed, thereby avoiding agricultural burning in rural areas.[14]

- If you have reached the conclusion that your only option is agricultural burning, consult <www.conafor.gob.mx:8080/biblioteca/ver.aspx?articulo=446> to learn how to use this practice in a responsible manner. For more information regarding agricultural burning, also visit <www.epa.gov/agriculture/tburn.html>.

- Energy extraction. There are a number of ways commonly used to extract energy from biomass, such as corn, sugar cane, wood, grasses and some agricultural waste. There are two basic alternatives to obtaining energy from biomass: burning it or converting it into fuel. Even though it is preferable for the environment, converting biomass into biofuel continues to be somewhat inefficient and particularly costly, and at this time burning biomass to produce energy is more affordable.

[14] See <www.guanajuato.gob.mx/noticia_detalle.php/7794>.