MAIZED AND CONFUSED: HOW PESTICIDE REGULATIONS IN THE UNITED STATES AND BRAZIL ARE FAILING TO PROTECT MAIZE CROPS IN THE FACE OF CLIMATE CHANGE

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INTRODUCTION

Climate change is one of the most pressing and widely debated issues of this generation. Rising global temperatures and carbon dioxide levels trigger a list of problems felt all over the world. These impacts include more volatile weather events, longer or shorter seasons, changes in animal lifecycles, and extreme conditions, such as drought, flooding, heat, and cold. These factors contribute to an interlocking and inescapable web of consequences that are altering life on Earth. One such consequence is changes to crops, due mainly to issues with temperature, weather, water, and pests.[1] The risks of food-borne contamination and illness are increasing as farmers scramble to adjust their techniques to account for these threats.[2]

Maize (corn) is the highest-produced grain in the world.[3] Maize is one of the main sources of calories for hundreds of millions of people and is the number-one feed grain for animals, consumed indirectly through eggs, milk, and meat products.[4] It is also the crop that is most negatively affected by climate change.[5] High temperatures and drought are two factors that damage maize crops and contribute to smaller harvests.[6] Changes in temperature and moisture are also the two main determinants for pests and diseases.[7] Use of pesticides is expected to increase as farmers account for greater infections in crops.[8] This in turn creates an increased risk of illness in consumers when eating maize directly, consuming animal products from maize-fed livestock, or being exposed to pesticides in the environment.

The United States and Brazil are the top two exporters of maize in the world and are two of the top three producers (China produces more

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1 *Food Safety, Climate Change, and the Role of WHO*, ASIA PAC. OBSERVATORY ON HEALTH SYS. AND POLICIES. (31 July 2019), https://apo.who.int/publications/i/item/food-safety-climate-change-and-the-role-of-who [https://perma.cc/V7Q3-7C77].

2 *Id.*

3 *Worldwide Production of Grain in 2020/21, By Type*, STATISTA (Jan. 31, 2022), https://www.statista.com/statistics/263977/world-grain-production-by-type/ [https://perma.cc/G63T-7NVA].

4 *Why Maize*, CGIAR RSCH. PROGRAM ON MAIZE (Oct. 10, 2021), https://archive.maize.org/why-maize/ [https://perma.cc/287W-4SMQ].

5 Matteo Zampieri, A. Ceglar, Frank Dentener, Alessandro Dosio, Gustavo Naumann, M. van den Berg & Andrea Toreti, *When Will Current Climate Extremes Affecting Maize Production Become the Norm?*, 7 EARTH'S FUTURE 113, 114 (2019).

6 *Id.*

7 ASIA PAC., *supra* note 1.

8 *Id.*

than Brazil but exports less).[9] These two countries provide most of the world's exported maize, but fail to protect their maize and its consumers from the threats of climate change. Brazil is the fastest growing consumer of pesticides in the world, driven largely by deregulation.[10] The United States uses seventy-two pesticides for outdoor agriculture that have been banned by the European Union.[11] Residual chemicals in maize and subsequent health issues in people and animals are rising concerns; however, lower crop yields are also causing pressure as growers try to maintain production to avoid food insecurity and spiking prices.[12]

This note argues that the regulatory schemes in the United States and Brazil are woefully behind in adapting to the problems facing maize production and are not comprehensive enough to remedy issues stemming from climate change, particularly a rise in chemical pesticide usage. Part I will explain how climate change is altering maize production and the regulations currently in place for each country. Part II will highlight lapses in the regulations and critique the reactions of Brazil and the United States as not being extensive or aggressive enough. Part II will also suggest solutions to these regulatory failures and introduce ways in which other countries are regulating pesticides in the face of climate change. Finally, the note will conclude that both countries should implement broad and innovative remedial regulations to protect maize crops and everything that depends on them.

I. BACKGROUND

The overlapping considerations involved in climate change, farming, the economy, global food consumption, and regulatory action create a complex ecosystem that reaches across the world. There is considerable tension between protecting health and safety, preserving crops in the face of climate change, and maintaining the economy on

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[9] *Global Corn Production in 2020/21, By Country*, STATISTA (July 27, 2022), https://www.statista.com/statistics/254292/global-corn-production-by-country/ [https://perma.cc/LJ7V-DHDR]; *Export Volume of Corn Worldwide in 2020/21, By Country*, STATISTA (Jan. 31, 2022), https://www.statista.com/statistics/254299/top-global-corn-exporters/ [https://perma.cc/Y5ZK-HTNJ].

[10] Jenny Gonzales, *Brazil's Fundamental Pesticide Law Under Attack*, MONGABAY (Feb. 20, 2018), https://news.mongabay.com/2018/02/brazils-fundamental-pesticide-law-under-attack/ [https://perma.cc/PW3J-X5FP].

[11] Nathan Donley, *The USA Lags Behind Other Agricultural Nations in Banning Harmful Pesticides*, 18 ENV'T HEALTH J. 44, 44 (2019).

[12] ASIA PAC., *supra* note 1.

various levels. So far, the reaction of the United States and Brazil has been to focus on the economic value of crops and place the greatest emphasis on securing large yields of maize, despite crop struggles due to climate change. This negatively affects consumer and environmental protections, especially with pesticide use and regulation.

A. FACTORS IMPACTING MAIZE GROWTH AND THE GLOBAL EFFECTS OF COMPROMISED MAIZE YIELD

Climate change, at its most basic, is the shift of climate patterns over time. NASA has traced seven glacial advances and retreats in the 650,000 years prior to human civilization.[13] These cycles match the rise and fall of carbon dioxide (CO_2) levels in the atmosphere.[14] Concern arises from the fact that the current trends show only an increase of CO_2, and a rapid one at that, starting in 1950.[15] CO_2 is the most prominent type of greenhouse gas, a term used to describe gases that trap heat in the atmosphere and warm the planet.[16] The average surface temperature of the planet has risen about 2°F since the late 19th century, indisputably due to human activities[17] like transportation, industry, electricity, and agriculture.[18] As a result of rising CO_2 levels in the atmosphere, temperatures will continue to rise, precipitation levels will increase or decrease in different regions, there will be more droughts and heat waves, extreme weather events will happen more frequently and with greater force, and sea levels will rise.[19]

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[13] *What is the Evidence for Human-Caused Climate Change?* CALTECH, https://scienceexchange.caltech.edu/topics/sustainability/evidence-climate-change [https://perma.cc/6L9P-22FB] (last visited Oct. 20, 2022).

[14] *Id.*

[15] *Id.*

[16] *Sources of Greenhouse Gas Emissions*, ENV'T PROT. AGENCY, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions [https://perma.cc/63V2-RRA3] (last visited Oct. 24, 2021).

[17] Mark Lynas, Benjamin Z. Houlton & Simon Perry, *Greater than 99% Consensus on Human Caused Climate Change in the Peer-Reviewed Scientific Literature*, ENV'T RSCH. LETTERS (2022).

[18] How Do We Know Climate Change is Real?, NASA, https://climate.nasa.gov/evidence/ [https://perma.cc/PL3M-SNK3] (last visited Oct. 24, 2021); *Global Greenhouse Gas Emissions Data*, ENV'T PROT. AGENCY, https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data [https://perma.cc/8NAP-T2UJ] (last visited Oct. 24, 2021).

[19] *The Effects of Climate Change*, NASA, https://climate.nasa.gov/effects/ [https://perma.cc/BSF4-KSET] (last visited Oct. 24, 2021).

It is nearly impossible to overstate the intricacies of climate change, crop production, and their interaction with each other. However, two main themes persist through decades of studies: temperature and water. The optimal conditions for growing maize are temperatures between 68°F and 73°F and at least 18–20 inches of moisture available for the entire crop growing season.[20] Stress induced by high temperatures during ear formation, reproduction, and grain fill[21] stages can be detrimental to yields.[22] Yield is reduced by 1 ½ bushels per acre every day the temperature is above 95°F during the tasseling-silking[23] or grain fill phases.[24] The plant's water demands increase as it grows, reaching a peak during tasseling.[25] Precipitation, plus additional soil moisture, is typically enough to satisfy the crop during this time.[26]

Conditions outside of these optimal averages can have devastating effects on the crop. Year over year, variation in yield is due mostly to differences in weather, with changes in rainfall and temperature being the main drivers.[27] Recent major losses in yield have been attributed to precipitation extremes, generally too little rainfall but occasionally too much.[28] Drought delays female organ development in maize and inhibits photosynthesis.[29] It also makes the maize more

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[20] Ralph E. Neild & James E. Newman, *Growing Season Characteristics and Requirements in the Corn Belt*, *in* NAT'L CORN HANDBOOK (Purdue Univ. ed., 1990).

[21] The grain fill stage of maize refers to the kernel development period. Grain fill begins with pollination and concludes about 60 days later, when the kernels are mature. Bob Nielson, *Kernel Development Stages in Corn*, PURDUE UNIV., https://www.agry.purdue.edu/ext/corn/pubs/corn-03.htm [https://perma.cc/78KN-Y7XA] (last visited July 24, 2022).

[22] Neild, *supra* note 20.

[23] Silking refers to a stage of maize growth where part of the plant emerges from the husk to receive pollination and begin the fertilization process. Erick Larson, *Identifying Corn Reproductive Growth Stages and Management Implications*, MISS. STATE UNIV., (July 5, 2018), https://www.mississippi-crops.com/2018/07/05/identifying-corn-reproductive-growth-stages-and-management-implications/ [https://perma.cc/3KVA-8MXL]; Tasseling is the stage of maize growth where the male part of the plant emerges from the ear in preparation to pollinate. Bob Nielson, *Tassels in Corn*, PURDUE UNIV., (Oct. 2019), https://www.agry.purdue.edu/ext/corn/news/timeless/TasselEars.html [https://perma.cc/695U-DLH5]**;** Tasseling occurs immediately before silking but the two stages must essentially coincide for proper pollination of the plant. Larson, *supra*.

[24] Neild, *supra* note 20.

[25] *Id.*

[26] *Id.*

[27] JEFFREY AMTHOR, SUBODH ACHARYA, & JULIA BORMAN, QUANTIFYING THE IMPACT OF CLIMATE CHANGE ON U.S. CORN YIELDS 12 (Air Worldwide ed., 2021).

[28] *Id.* at 13.

[29] Zampieri, *supra* note 5, at 114.

vulnerable to heat stress.[30] Heat stress causes issues at various phases of growth and can compromise the crop's photosynthetic rate, water-use efficiency, pollen germination, and kernel filling.[31] Additionally, temperature and water variation can threaten maize yield indirectly by creating conditions favorable to insects, diseases, and weeds.[32] Excessive moisture can promote bacterial growth, and a warmer winter or spring will extend the life of pests or permit their activity earlier in the year.[33]

Studies comparing expected climate changes with expected maize yields show a downward trend in yearly yields, as well as a decrease in yield stability year over year.[34] Weather is the main reason for changes in yearly yield, and the skew towards lower yields indicates poor weather is more detrimental than good weather is beneficial.[35] This has serious implications for the local and global economy, supply chains, and food security. A 50% loss of the US maize crop would result in a $25–30 billion financial loss.[36] Rural farming communities would feel this loss most immediately. In developing countries people rely on maize as a main source of income.[37] Maize is also a major source of livestock feed, so lower yields will impact price and production of animal products like eggs, milk, and meat. Billions of people rely on maize as a staple of their diet.[38] Low yields will cause hunger and malnutrition for these populations, as well as drive up the cost of maize, which disproportionately impacts poorer countries and low-income households.[39]

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[30] *Id.*

[31] *Id.* at 113.

[32] AMTHOR, *supra* note 27, at 13; Nereu Augusto Streck, *Climate Change and Agroecosystems: The Effect of Elevated Atmospheric CO2 and Temperature on Crop Growth, Development, and Yield*, 35 CIÊNCIA RURAL 732, 736–37 (2005).

[33] AMTHOR, *supra* note 27, at 13; Streck, *supra* note 32, at 736–37.

[34] AMTHOR, *supra* note 27, at 18.

[35] *Id.* at 13.

[36] *Id.* at 17.

[37] CGIAR RSCH., *supra* note 4.

[38] *Id.* (maize provides 30 percent of food calories for 4.5 billion people in developing countries).

[39] CGIAR RSCH., *supra* note 4; Chelsea Harvey, *Rising Temperature Could Cut Corn Production*, SCI. AM. (June 12, 2018), https://www.scientificamerican.com/article/rising-temperatures-could-cut-corn-production/ [https://perma.cc/2L2A-665V].

B. THE USE OF PESTICIDES TO MAINTAIN YIELD AND THE EFFECTS OF PESTICIDE EXPOSURE

In an attempt to counteract the impacts of climate change on maize crops, farmers are adjusting growing techniques. Depending on the region and conditions, such as climate and soil, these changes may include changes to irrigation and drainage, different planting and harvesting times, and pesticides. Pesticides prevent or mitigate damage to crops from insects, diseases, and weeds. They offer a competitive advantage for agricultural crops in the field.[40] The effect of climate change on insects and diseases, as well as on the pesticides themselves, suggest that pesticide use will need to be increased to keep crops healthy.[41]

Both insects and diseases thrive in the conditions facilitated by climate change. Warmer temperatures lead to earlier appearances and longer periods of insect activity.[42] More precipitation encourages insect growth and geographic shifts in the insects' habitat, changing their range and exposing more crops to damage.[43] Climate change will increase the severity of diseases in plants by accelerating the growth and dispersal of spores, fungi, and bacteria.[44] Farmers will need to utilize more pesticides to compensate for these threats.

Additionally, pesticide effectiveness is impaired by climate change, which furthers the need for more pesticide use. Pesticide efficiency is limited by transport and degradation.[45] Transport of pesticides happens when pesticides transfer to a gaseous phase and absorb into the atmosphere, when water runoff from the parcel of land the crop is growing on moves to other surface water, and when the pesticide chemicals leach into the soil and eventually reach groundwater.[46] High temperatures and direct exposure to sunlight expedite pesticide dispersal into the atmosphere.[47] Temperature also has a

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[40] Ilse Delcour, Pieter Spanoghe & Mieke Uttendaele, *Literature Review: Impact of Climate Change on Pesticide Use*, 68 FOOD RSCH. INT'L 7, 8 (2014).

[41] *Id.* at 13.

[42] *Id.* at 10.

[43] *Id.* at 9–10.

[44] *Id.* at 10.

[45] *Id.* at 11.

[46] *Id.* at 11–12.

[47] *Id.* at 11.

positive effect on the amount of chemicals that leach into the soil.[48] High levels of precipitation are the driving force behind runoff of pesticides in surface water and also influence leaching.[49] Degradation, or the breaking down of pesticides, happens more quickly under climate change conditions because it accelerates microbial and chemical reaction rates.[50] As pesticides are transporting and degrading more quickly, they will need to be applied to the crops more often.

Pesticides can have negative effects on human health if consumed or inhaled. In extreme cases these chemicals can cause cancer, have effects on reproduction, and damage immune and nervous systems.[51] The hazard a pesticide poses is based on the toxicity level of the pesticide and the amount of exposure a person has to it.[52] Residue of pesticides can be found in nearly every food and beverage item, including cooked meals and water.[53] Pesticide residue has even been detected in human breast milk.[54] While these residue levels are usually below what has legislatively been deemed safe, the limits are set for individual pesticides—and a single product can have multiple substances.[55] Even when there is compliance with standardized residue levels, evidence still shows that exposure to these chemicals correlates with negative health effects.[56]

C. PESTICIDE REGULATION IN THE US AND BRAZIL

As the two largest exporters of maize, the agricultural habits of the United States and Brazil set an example for the rest of the world. Billions of people depend on their yields being successful. Both countries rely heavily on pesticide use to protect maize crops: the United

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[48] *Id.* at 12.

[49] *Id.*

[50] *Id.*

[51] *Food Safety: Pesticide Residue*, WORLD HEALTH ORG. (May 16, 2016), https://www.who.int/news-room/q-a-detail/food-safety-pesticide-residue [https://perma.cc/4LXD-MMJG].

[52] *Potential Health Effects of Pesticides*, PA. STATE UNIV. EXTENSION (Sept. 13, 2017), https://extension.psu.edu/potential-health-effects-of-pesticides [https://perma.cc/7F5C-X7KF].

[53] Polyxeni Nicolopoulou-Stamati, Sotirios Maipas, Chrysanthi Kotampasi, Panagiotis Stamatis & Luc Hens, *Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture*, 4 FRONTIERS PUB. HEALTH 1, 1 (2016).

[54] *Id.* at 2.

[55] *Pesticides in Our Food System*, FOOD PRINT (Feb. 8, 2021), https://foodprint.org/issues/pesticides/ [https://perma.cc/2PZX-J28G].

[56] *See* Nicolopoulou-Stamati, *supra* note 53, at 2.

States uses about 1 billion pounds of pesticides in a year,[57] and Brazil uses about 670 million pounds.[58]

In the United States, pesticides fall under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This Act sets out the minimum requirements and procedures for pesticide registration and use.[59] It also delegates authority to the Environmental Protection Agency (EPA) and its Administrator to oversee regulation of pesticides and make various determinations about how the Act will be followed and enforced.[60] The FIFRA authorizes the EPA to register pesticides for use and establish the maximum permissible levels for pesticide residue in foods.[61] Registration of a pesticide requires applicants to submit the labeling, chemical formula, and a full description of tests and results.[62] The Administrator of the EPA will consider the data and either register the pesticide or, if the Administrator determines the application does not comply with the statutory requirements, deny the application.[63] The Administrator can also request additional data to maintain existing registrations.[64] It is within the Administrator's authority to establish or leave in effect a tolerance for a pesticide chemical if the Administrator has determined it is safe.[65] A pesticide residue is considered safe if there is reasonable certainty that no harm will result from exposure to the chemical, including all dietary exposures.[66]

Despite these standards in place for pesticide regulation, the United States allows the use of dozens of pesticides that have been banned in the European Union, China, and even Brazil.[67] A majority of the pesticides allowed in the United States, but banned in other countries, have had consistent usage in the twenty-five years from 1994–2019, with

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[57] Ohio-Kentucky-Indiana Water Science Center, *Pesticides*, U.S. GEO. SURV. (Mar. 23, 2017), https://www.usgs.gov/centers/oki-water/science/pesticides?qt-science_center_objects=0#qt-science_center_objects [https://perma.cc/XC4U-YTN4].

[58] Jenny Gonzales, *Brazil Sets Record for Highly Dangerous Pesticide Consumption: Report*, MONGABAY (Mar. 12, 2020), https://news.mongabay.com/2020/03/brazil-sets-record-for-highly-hazardous-pesticide-consumption-report/ [https://perma.cc/9PAB-HJ5Z].

[59] *See generally* 7 U.S.C. § 136a; 7 U.S.C. § 136c; 7 U.S.C. § 136i; 7 U.S.C. § 136k.

[60] 7 U.S.C. § 136a(c); 7 U.S.C. § 136a(d); 7 U.S.C. § 136w.

[61] 7 U.S.C. § 136a(c); 21 U.S.C. § 346a.

[62] 7 U.S.C. § 136a(c)(1).

[63] 7 U.S.C. § 136a(c)(3)(A).

[64] 7 U.S.C. § 136a(c)(2)(B)(i).

[65] 21 U.S.C. § 346a(b)(2)(A)(i).

[66] 21 U.S.C. § 346a(b)(2)(A)(ii).

[67] Donley, *supra* note 11, at 3.

some having increased usage in the last ten years of that same period.[68] The EPA has also been slow to initiate reviews of currently registered pesticides, meaning products largely remain available regardless of health and safety considerations or technological advances, unless the private entity voluntarily cancels the registration.[69]

Pesticide regulation in Brazil is controlled by Law 6299, but before that it was controlled by Law 7802. Referred to as The Pesticide Law, Law 7802 dictated research, production, labeling, packaging, classification, and use of pesticides.[70] Further clarification on pesticide control was given in Decree 4074, which was implemented under The Pesticide Law, and Decree 5981, which amends certain provisions of Decree 4074. These laws give oversight of pesticide approval and usage in Brazil to three agencies: the Brazilian Ministry of Agriculture (MOA), Brazilian Health Advisory Agency (Anvisa), and the Ministry of the Environment (MOE).[71] Similar to the United States, applicants must submit all information about the pesticide and its usage to the agriculture, health, and environment sectors.[72] The agencies can also reevaluate registrations when new risks are uncovered, the government is warned of risks by an international body, or a safer or more efficient alternative becomes available.[73]

When first enacted in 1989, Law 7802 was one of the strictest pesticide laws in the world.[74] However, an explosion in Brazilian farming has pushed enforcement into the background.[75] In 2000, Brazil produced $6.5 billion in grain.[76] By 2016, Brazilian grain was valued at $54.8

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[68] *Id.* at 2.

[69] *Id.* at 5.

[70] *Decree No. 4.074 regulating Law No. 7.802 on research, production, labelling, packaging, exploitation, classification, use, etc. of pesticides*, ECOLEX, https://www.ecolex.org/details/legislation/decree-no-4074-regulating-law-no-7802-on-research-production-labelling-packaging-exploitation-classification-use-etc-of-pesticides-lex-faoc048739/ [https://perma.cc/8YFN-9C8R] (last visited Feb. 20, 2022).

[71] Donley, *supra* note 11, at 2.

[72] Lin Fang, *Brazilian Pesticide Regulation Overview*, CHEMLINKED (Mar. 13, 2017), https://agrochemical.chemlinked.com/chempedia/brazilian-pesticide-regulation-overview [https://perma.cc/7R4Z-6SLZ].

[73] *Id.*

[74] Gonzales, *supra* note 10.

[75] Maria Laura Canineu, *Brazil's Dangerous Open Door for Toxic Pesticides*, HUM. RTS. WATCH (July 26, 2019, 11:46 AM), https://www.hrw.org/news/2019/07/26/brazils-dangerous-open-door-toxic-pesticides# [https://perma.cc/FRS9-3K82].

[76] Gonzales, *supra* note 10.

billion.[77] To facilitate this boom in the agriculture business, Brazilian authorities registered pesticides in waves. Four hundred and fifty new pesticides were approved for use in 2018, more than in any of the previous thirteen years.[78] There were also attacks on Law 7802 through the legislative process, with groups pushing to change pesticide regulation standards from a hazard analysis to a risk assessment.[79] The hazard analysis rejects any pesticide that has been shown to possess significant hazards to health or the environment, while a risk assessment is based on the probability of a hazard occurring when the product is used.[80] A risk assessment standard allows for more pesticide approvals by eliminating extensive study requirements and permitting a higher level of uncertainty in the decision-making process.[81] These legislative attacks succeeded in 2018 with the passing of Law 6299, which significantly relaxed the previous standards.[82]

II. ANALYSIS

Current pesticide regulations in the United States and Brazil are lacking. They are especially susceptible to economic and political pressures and either woefully behind on addressing the climate crisis or actively working against protecting the health of people and the environment. The lapses in these laws are particularly worrisome because of the sheer amount of pesticide that these countries use. Additionally, much of the world relies on their maize exports. These countries should have an outstanding interest in protecting their crops without contributing to more environmental damages, which will ultimately keep threatening the wellbeing of the crops.

A more stringent and streamlined regulatory process will help mitigate health hazards associated with pesticide use and encourage innovative advancements in curbing the effects of climate change and protecting maize. A simple cost-benefit analysis or search for potential

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[77] *Id.*

[78] Natália Cancian, *Pesticides Approved For Sale Reached Record High in 2018*, FOLHA DE S.PAULO (Mar. 6, 2019, 6:49 PM), https://www1.folha.uol.com.br/internacional/en/brazil/2019/03/pesticides-approved-for-sale-reached-record-high-in-2018.shtml [https://perma.cc/RY77-ZX3F].

[79] Gonzales, *supra* note 10.

[80] *Id.*

[81] *Id.*

[82] Marcelo Firpo de Souza Porto, *The Tragic "Poison Package": Lessons for Brazilian Society and Public Health*, 34 CADERNOS DE SAÚDE PÚBLICA, no. 7, 2018, at 1.

environmental risks no longer serves as an acceptable standard for approving pesticides for use. Now that climate change has created scenarios where pesticide use must increase to manage crop growth, the main concern of approving pesticides needs to be the impact to health. This should be paired with a focus on minimizing or negating the factors that contribute to increases in pesticide use to begin with. The result would be better protection for humans and the environment through lower risks to maize yield, less demand for pesticides, and safer alternatives for protecting crops.

A. HOW CURRENT REGULATIONS ARE FAILING

There are several instances along the pesticide regulation pipeline where the United States could be more proactive. Instead, regulators have opted for a relaxed approach that is slowly but steadily causing the country to fall behind the situation. There are noticeable gaps in the requirements for registering a pesticide and significant barriers to cancelling registration of a pesticide. There is complex interworking between the FIFRA and the EPA's regulations, and the Administrator of the EPA has ample authority over every aspect of pesticide registration. The result is a complicated and outdated regulatory scheme that does little to mitigate issues brought on by climate change.

Meanwhile, Brazil is backing away from what was once the world's strictest pesticide control law and is instead supporting sweeping approvals of chemical pesticides. The change has been facilitated by decades of pro-agriculture governments that place the highest value on farming outputs and the effect on the Brazilian economy.[83] The emphasis on farming resulted in a boom in Brazilian agriculture production and exportation but has also led to increases in dangerous pesticide exposures.[84] In order to allow more pesticide use, the government undermined the Ministry of the Environment and Brazilian Health Advisory Agency.[85] Now there are little to no means of enforcement or ensuring compliance with the laws that are in place.[86]

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[83] Cancian, *supra* note 78; Firpo de Souza Porto, *supra* note 82.

[84] Maria Laura Canineu, *Brazil Needs More Pesticide Regulation, Not Less*, HUM. RTS. WATCH (Dec. 23, 2019), https://www.hrw.org/news/2019/12/23/brazil-needs-more-pesticide-regulation-not-less [https://perma.cc/ED73-TYAF].

[85] Firpo de Souza Porto, *supra* note 82.

[86] *Id.*

1. The United States' Lackluster Method of Managing Pesticides

The first step in the pesticide approval process begins with the proponent of the registration. Registrants of pesticides are required to submit a statement to the EPA that includes the name of the pesticide, complete labeling and directions for use, complete formula of the pesticide, and a full description of the tests made and results upon which the claims about the pesticide are based.[87] The Administrator of the EPA has statutory authority to dictate exactly what kind of results must be submitted to support the registration of a pesticide, but the registrant is responsible for initiating the studies and compiling that information.[88]

Placing the burden of supplying the data on the registrant has cost and time benefits. The EPA cannot be expected to conduct studies on every pesticide and all their conceivable uses just in case an entity requests registration of that pesticide. However, this puts the registrant in control of what data the EPA relies on when making a registration decision. To balance this, the Administrator has the power to request more information from a registrant if they decide the initial data is insufficient.[89] The registrant is then able to self-correct but still controls the supplemental information. Ensuring adequate studies and reporting rests solely on the data requirements set out by the EPA in Title 40 of the Federal Code of Regulations, and registrants' compliance with those requirements.[90] The Administrator is mandated with revising the guidelines "from time to time" but the data for pesticide regulations is only as good as the Administrator requires it to be.[91] Different Administrators can change these baseline requirements to make this step easier or more arduous for registrants.

Once the studies have been conducted and submitted, the Administrator reviews them for certain criteria. The Administrator must register a pesticide that warrants the proposed claims, has accurate and compliant labeling, will perform its intended function without unreasonable adverse effects on the environment, and, when used with widespread and common practice, will not generally cause unreasonable adverse effects on the environment.[92] Unreasonable adverse effects on

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87 7 U.S.C. § 136a(c)(1).

88 7 U.S.C. § 136(a)(2)(A); 40 F.C.R. §§ 158.3–.5 (2021).

89 7 U.S.C. § 136a(c)(2)(B)(i).

90 40 F.C.R. § 158.1 (2021).

91 7 U.S.C. § 136a(c)(2)(A).

92 7 U.S.C. § 136a(c)(5).

the environment mean (1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard in the Federal Food, Drug, and Cosmetic Act (FFDCA).[93] The Administrator is not allowed to make lack of essentiality a reason for denying an application for registration.[94]

The standard of review and the prohibition on considering essentiality means more value can be placed on the economic benefit of a pesticide than the environmental and health concerns. The Administrator is required to register pesticides that do what they say they will and have proper labeling, so long as there are no unreasonable adverse effects on the environment. Determining the reasonableness of the effects is based on a cost-benefit analysis that expressly allows economic considerations. This standard gives an Administrator the ability to construe nearly any pesticide as passing the reasonable risk test so long as there is adequate financial benefit, whether that be in terms of profits to the registrant or to farmers.

There are also limited situations in which use of a pesticide avoids the standard registration process. These exemptions include treated substances, which contain a pesticide for the sake of protecting the substance itself. Examples given include paint with pesticides to protect the coating or wood treated with pesticides to repel insects.[95] This exemption is conditional on the pesticide used to treat the substance already having been approved for such use.[96] This is a blanket exclusion from all provisions of the FIFRA. The implicit assumption is that the use of pesticides in these substances is controlled by other regulations or not at all. There is no reference to what statute or regulation these may fall under, and no requirements are implemented under the EPA. Lack of continuity between the statutes and absence of any provisions in the section leave the legitimacy of these substances up in the air.

The regulatory scheme is designed so that once a pesticide is registered, it remains. After the initial registration, regulators have fifteen years before they have to review the registration again.[97] Subsequent

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93 7 U.S.C. § 136(bb); *see generally* 21 U.S.C. § 146a.

94 7 U.S.C. § 136a(c)(5).

95 40 F.C.R. § 152.25(a) (2021).

96 *Id.*

97 7 U.S.C. § 136a(g)(1)(A)(i)–(iii).

reviews are required every fifteen years.[98] Regulators can choose to review a registration before the fifteen-year period is over, but that requires the EPA to actively seek out which registrations may need review. The number of registrations could make this a tedious task. Review of a registration requires that a pesticide complies with the standard for registration and is based on current knowledge.[99] The Administrator is required to undertake research and monitoring as necessary, but the specifics have been left to the discretion of the Administrator.[100] If, based on reviewing or monitoring, the Administrator thinks a pesticide does not comply with FIFRA, they can issue a notice of intent to cancel the registration or hold a hearing to determine if the registration should be cancelled.[101] It is also possible for a registrant to request a voluntary cancellation of a registration.[102] The Administrator must publish a notice of the request for cancellation and allow thirty days for public comment.[103] The Administrator may choose not to act on the voluntary cancellation request for 180 days if the pesticide in question is registered for minor agricultural use or cancellation will adversely affect availability.[104] The ultimate decision to approve or deny the cancellation request is one for the Administrator.[105]

This setup has resulted in a pileup of pesticides on the registration list and few removals, particularly through the regulator-initiated process. It is wholly possible that registered pesticides are not considered again until the fifteen-year period has elapsed. But a lot can change in fifteen years, especially considering the rate at which climate change is progressing and that technology and science are advancing. Revisiting registrations every fifteen years does not do enough to keep the list of registered pesticides up to date. Statutory requirements for continuous monitoring of pesticides in use are substantially-less structured than the process for initial registration. There is also no mandate for continued study of the effects of pesticide use. Studies on health and the environmental impacts of exposure continue to become

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98 7 U.S.C. § 136(a)(g)(1)(A)(iv).
99 40 F.C.R. § 155.40(a)(1)–(2) (2021).
100 7 U.S.C. § 136r.
101 7 U.S.C. § 136d(b).
102 7 U.S.C. § 136d(f)(1)(A).
103 7 U.S.C. § 136d(f)(1)(B).
104 7 U.S.C. § 136d(f)(1)(C).
105 7 U.S.C. § 136d(f)(1)(D).

more accurate over time, as does knowledge about effectiveness and other benefits.

Since monitoring is determined by the Administrator, it is possible for the EPA to place priorities elsewhere and simply maintain minimal compliance with the FIFRA. This diversion of priorities can be seen in the amount of regulator-initiated and registrant-initiated cancellations that have taken place in the past decades. Since 1980 there have been more voluntary than non-voluntary cancellations of registrations, with the gap widening from nine voluntary and eight non-voluntary cancellations in the 1980s to thirty-four voluntary and one non-voluntary in the 2010s.[106] Evidence suggests that most voluntary cancellations are motivated by economic, rather than health or environmental, considerations.[107] Voluntary cancellation allows registrants to keep manufacturing the pesticide for four years with a phase-out period of an additional four years, contrasted with the one-year phase-out for involuntarily-cancelled pesticides.[108] This means that without the EPA taking initiative to review and cancel registrations, pesticides may remain on the market until the registrant is not able to justify the cost of the registration fee compared with the profit. Even after that happens, the pesticide is available for eight more years. Overall, the process to cancel a registration is arduous and does not lend itself to making critical updates to the registered pesticide list.

All these factors contribute to pesticide regulations that are mostly up to Administrator choice and can be prone to economic and political influence. It also fails to create a scheme that properly adapts to environmental and scientific changes. The reactive versus proactive approach leaves much wanting in terms of a comprehensive regulation system that is suited to the realities of climate change and providing adequate protection for people, crops, and the environment.

2. Brazil's Race to Deregulate Pesticides

Brazil's approach to pesticide regulation can be described as a full-on sprint into chaos. While control has been relaxing since the mid-2010s, the policies of current president Jair Bolsonaro have invited what is essentially a pesticide free-for-all. Pesticides are being approved in

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[106] Donley, *supra* note 11, at 6.
[107] *Id.* at 8.
[108] *Id.*

droves, and environmental laws and agencies are being scaled back.[109] This comes mostly from a desire to boost the agriculture industry in Brazil, but this preference for the economy is happening at the expense of the environment and health of Brazilians. The approach is also critiqued for being too aggressive and allowing approval of pesticides that either are not necessary or are excessively toxic.[110]

The largest legislative challenge to Brazil's pesticide laws came in 2018, in the form of Law 6299.[111] This new law gutted Law 7802 and replaced the previous protections with less-strict standards.[112] It made the registration system more flexible and removed consideration of health and environment impacts. It limited the role of the Ministry of the Environment (MOE) and the Brazilian Health Advisory Agency (Anvisa), giving more authority to the Ministry of Agriculture (MOA).[113] It also changed the term "agrotoxin" (what Brazilians refer to pesticides as) to "phytosanitary defensive," which confuses consumers and implies that the substance is safer than it is.[114]

Prior to the passage of Law 6299, Law 7802 was the controlling authority on pesticides in Brazil. It provided a straightforward foundation and authorized additional regulation through Decrees 4074 and 5981.[115] Similar to 7 U.S.C. § 136a(2) in the United States, Law 7802 required the registering establishment to provide all toxicological, environmental, and behavioral data of the pesticide, but additionally required that the results come from national or international laboratories.[116] Registration was prohibited if methods for deactivating the pesticide or proper treatment for exposure to the pesticide were not available in Brazil.[117] Pesticides that showed any carcinogenic characteristics or could cause damage to the environment were also prohibited from registration.[118]

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[109] Canineu, *supra* note 84.

[110] Sue Branford & Thais Borges, *Brazil's Bolsonaro Green-Lights 150+ Pesticides this Year*, ECOWATCH (May 3, 2019), https://www.ecowatch.com/brazil-bolsonaro-pesticides-2636194015.html [https://perma.cc/SS3P-RTMB].

[111] *The Health of Brazilian Citizens Comes First: The Poison Pack Proposal Must be Rejected*, SLOW FOOD (May 24, 2018), https://www.slowfood.com/the-health-of-brazilian-citizens-comes-first-the-poison-pack-proposal-must-be-rejected/ [https://perma.cc/BKC3-WKP3].

[112] Firpo de Souza Porto, *supra* note 82.

[113] *Id.*

[114] *Id.*

[115] Lei No. 7.802, de 11 Julho de 1989, Diário Oficial da União [D.O.U] de 7.12.1989 (Braz.), art. 10, 19.

[116] *Id.* art. 5 § 1.

[117] *Id.* art. 3 § 6.

[118] *Id.*

On its own, Law 7802 created a very protective standard for pesticides. However, even before Law 6299, the specific regulations and the executive power of the government caused fractures in its coverage and pesticides were allowed to spill through the cracks and into Brazil's agricultural industry. Some of the law's weakness came from dueling authorities. Executive Decree 4074 assigns authority to the MOA, Anvisa, and the MOE.[119] Each ministry is given a different area of compliance that they are responsible for. Different priorities among the ministries, particularly the interests of agriculture against health and environment, could convolute the decision-making process. This made it easier for current pro-pesticide policies to get pushed though regulation because the health and environment sectors can be weakened but the MOA can still approve the registration.[120] This agency imbalance was solidified with the passage of Law 6299, which completely removed Anvisa and the MOE from aspects of the registration process and strengthened the regulatory powers of the MOA.[121]

Rapid approval of pesticides has resulted in two things: a flood of already available pesticides starting to be manufactured by more companies, and the allowance of pesticides that are not in use anywhere else. At least four large pesticide makers sell products in Brazil that are not approved for use in their own countries.[122] This encourages consumption of pesticides by making them readily available for any farmer to use, even though the interactions of all the formulations have not been studied and in some cases have been deemed extremely hazardous by other governments. The process of getting dangerous pesticides off the market is nearly impossible. Efforts by Anvisa to reevaluate approved pesticides are hindered by Anvisa's own resource limitations, lawsuits by manufacturers, and pushback from lawmakers.[123] Even more so than in the United States, approved pesticides are there to stay.

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[119] Decreto No. 4.074, de 4 Janeiro de 2002, Diário Oficial da União [D.O.U], de 8.1.2002 (Braz.), art. 2.

[120] Jill Langlois, *Brazilian Lawmakers Seek to Deregulate Pesticide Use and Ban Sale of Organic Produce in Major Supermarkets*, L.A. TIMES (Aug. 12, 2018), https://www.latimes.com/world/la-fg-brazil-farming-pesticides-20180812-htmlstory.html [https://perma.cc/JN5Z-LTKM].

[121] Firpo de Souza Porto, *supra* note 82.

[122] Companies based in the United States, Denmark, Germany and Sweden sell pesticides to Brazil that are not allowed in their domestic markets. Paulo Prada, *Why Brazil Has a Big Appetite for Risky Pesticides*, REUTERS (Apr. 2, 2015), https://www.reuters.com/investigates/special-report/brazil-pesticides/ [https://perma.cc/8P9M-VYBN].

[123] *Id.*

The massive amounts of pesticide approvals have been paired with a complete lack of enforcement or standard of compliance. Brazil's pesticide laws do not provide any specifications about the appropriate method of pesticide application. A favored technique in Brazil is aerial spraying, despite the amount of spray that gets carried by the wind to surrounding areas. There have been several instances of children and teachers in rural schools getting ill from pesticide drift.[124]

Even people living outside of rural farming areas are susceptible to poisoning. A 2018 study by Anvisa sampled fourteen popular foods from supermarkets in almost every Brazilian state.[125] The study showed dangerous levels of pesticide residue in a quarter of the samples.[126] Some of the residue was from pesticides that are banned in Brazil.[127] In 2015, Anvisa did a similar study that found 29% of sampled food had residue that exceeded permissible levels or contained banned pesticides.[128]

Even with lax enforcement of existing pesticide laws, Brazil has become home to a thriving illegal pesticide trade where unapproved pesticides are being brought into Brazil and sold for use in the country.[129] Some of the pesticides are illegal because of differences in regulations between countries.[130] These gaps between laws are allowing pesticide smuggling to thrive because the dealers can move product across borders and undercut prices.[131] However, some of the illegal products are illegitimate from the start, counterfeited in makeshift labs.[132] This underground pesticide trade increases the accessibility of dangerous chemicals. As the industry for pesticides grows in Brazil, so will the illegal market. Along the border with Paraguay, smugglers have been moving pesticides and producing their own. An Interpol investigator said

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[124] *You Don't Want to Breathe Poison Anymore*, HUM. RTS. WATCH (Jul. 20 2018), https://www.hrw.org/report/2018/07/20/you-dont-want-breathe-poison-anymore/failing-response-pesticide-drift-brazils [https://perma.cc/43QJ-DPKD].

[125] Canineu, *supra* note 84.

[126] *Id.*

[127] *Id.*

[128] Prada, *supra* note 122.

[129] Terrence McCoy, *In Agricultural Giant Brazil, a Growing Hazard: The Illegal Trade in Pesticides*, WASH. POST (Feb. 9, 2020), https://www.washingtonpost.com/world/the_americas/in-agricultural-giant-brazil-a-new-and-growing-hazard-the-illegal-trade-in-pesticides/2020/02/09/2c0b2f2e-30b3-11ea-a053-dc6d944ba776_story.html [https://perma.cc/2HNS-XPF8].

[130] *Id.*

[131] *Id.*

[132] *Id.*

five liters of illicit pesticides were selling for $800.[133] The penalty for selling illegal pesticides is a maximum of four years in prison, a quarter of the punishment for smuggling drugs.[134]

Pesticide regulation in Brazil is wholly out of control. The passage of Law 6299 and the structure of Law 7802 have allowed government leaders to warp the process and effectively negate any benefits that Law 7802 provided. The weakened MOE and Anvisa have been overpowered by a MOA working closely with a pro-agriculture government to further their agenda and permit more pesticides. In addition to floods of pesticides being approved for use, there is no accountability for use. This includes methods of application, worker safety, and consideration for the surrounding communities. The relaxed laws and frenzied pesticide market have opened the door for an illegal pesticide trade to move in—and traces of those illegal pesticides are being found in food all over the country. The situation has descended into utter chaos, and a complete overhaul of current regulations and enforcement would be necessary to get the country back on track.

B. METHODS OF MITIGATION AND OTHER SUGGESTED ALTERNATIVES

Considering the reliance on their maize production, the current approach to pesticide use by the United States and Brazil is not surprising. Their exports supply billions of people with food and drive billions of dollars in profit. However, a purely industry-focused approach is detrimental to the health of people, the environment, and, ultimately, the maize crop itself. By relying on pesticide use as a quick fix, the United States and Brazil are worsening the environmental threats to maize. Continuing down this path will trap the countries in an endless cycle, where using pesticides as a solution will ultimately contribute to the problem.

To break this cycle, both countries need to consider a more holistic solution rather than reliance on pesticides. As discussed earlier, climate change, crop production, and the economy are inseparable. Too much emphasis on one will cause the entire system to falter. The United States and Brazil are prioritizing their economies, but using pesticides to maintain production is a temporary solution that will ultimately become

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[133] *Id.*

[134] *Id.*

ineffective. Both countries need to curb their pesticide use and transition to solutions that will provide long-term protection for maize and the environment.

As the global leaders in maize production, the United States and Brazil should be at the forefront of protecting the longevity and viability of maize. Regulations in other countries have proven that strict pesticide usage laws are compatible with sustaining crop production levels. It is possible to reap the benefits of pesticides without sacrificing the health of workers and consumers or worsening the effects of climate change. The United States and Brazil need to implement more stringent pesticide laws that will reduce the number of pesticides being used and consider new alternatives to pesticides.

1. How the European Union is Successfully Regulating Pesticides

The United States and Brazil may be the largest exporters of maize, but other countries have been able to preserve significant crop industries while having strong pesticide restrictions. The European Union (EU) has the strictest pesticide laws in the world.[135] The approval process for active ingredients takes more than 3 years and involves assessments by the European Food Safety Authority (EFSA) and the relevant authorities in the Member States.[136] A company seeking approval of an active substance will submit an application to any Member State.[137] The Member State is tasked with the initial scientific and technical evaluation of the substance.[138] The Member State then sends an assessment to the EFSA, who conducts a peer review of the assessment in cooperation with the other EU Member States.[139] Results are sent to the European Commission, who makes a proposal about whether to approve or ban the substance.[140] The proposal is voted on by a regulatory committee comprised of representatives from each Member State.[141] Approval at the EU level does not automatically mean approval

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[135] *Pesticides Explained*, EUR. COMM'N, https://ec.europa.eu/assets/sante/food/plants/pesticides/lop/index.html [https://perma.cc/2Y39-A25L] (last visited Jan. 16, 2022).

[136] *Id.*

[137] *See id.*

[138] *Id.*

[139] *Id.*

[140] *Id.*

[141] *Id.*

at the country level. National authorities in each country are able to refuse or restrict the sale of pesticides, even if the pesticide is approved for use in another country.[142] If Member States do allow use of a pesticide, the European Commission regularly audits the Member States to ensure compliance with the legislation.[143]

Once a substance has been approved, the Commission reviews it regularly and continues to seek alternatives. Over the past twenty-five years, the European Commission, EFSA, and Member States have reviewed all substances approved for use in Europe.[144] When the process began there were over 1,000 active substances on the market, now there are around 400 still available.[145] The Commission prioritizes alternative pesticides by speeding up the approval process for low-risk substances.[146] Low-risk substances are not carcinogenic, mutagenic, toxic, explosive, or corrosive.[147] The Commission proactively flags substances on the market that could be replaced with a low-risk alternative.[148] The Commission also supports non-chemical alternatives by requiring Integrated Pest Management.[149] Member States are required to give preference to non-pesticide options whenever possible.[150]

The European Union used 730 million pounds of pesticides in 2019 and produced 131.8 million tons of their main crop, wheat, and 70 million tons of maize.[151] Total agriculture output that year was €418

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[142] *Id.*

[143] *See id.*

[144] *Id.*

[145] *Id.*

[146] *See id.*

[147] Council Regulation 1107/2009, Annex II, 2009 O.J. (L 309) 45 (EC).

[148] EUR. COMM'N, *supra* note 135.

[149] *Id.*; *Integrated Pest Management*, EUR. COMM'N, https://food.ec.europa.eu/plants/pesticides/sustainable-use-pesticides/integrated-pest-management-ipm_en [https://perma.cc/5UXH-5KD9] (last visited July 23, 2022). (explaining that Integrated Pest Management considers all available plant protection methods and integrates measures that protect plants, are economically and ecologically justified, and reduce or minimize risks and harm to humans and the environment while emphasizing growing a healthy crop with the least possible disruption to ecosystems).

[150] *See* EUR. COMM'N, *supra* note 135.

[151] *See Agri-environmental Indicator–Composition of Pesticides*, EUROSTAT (Apr. 2022), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agri-environmental_indicator_-_consumption_of_pesticides [https://perma.cc/8CTC-PBFW]; *Agricultural Production–Crops*, EUROSTAT (Nov. 2021), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agricultural_production_-_crops [https://perma.cc/2W5G-2448].

million euros ($477 million dollars).[152] By comparison, the United States uses about 1 billion pounds of pesticides in a year with maize output valued at $61 billion.[153] Brazil uses about 670 million pounds of pesticides and grain output was valued at $54.8 billion in 2016.[154] While overall crop production and export in the EU is lower than maize production and exports in the United States and Brazil, their system proves that it is possible to use pesticides responsibly without sacrificing agriculture. Their rigorous approval process and promotion of low-risk or non-chemical alternatives helps ensure that the methods used are the safest for the crops, people, and the environment. Their willingness to review and remove product from the market prevents an excessive accumulation of registrations and guarantees inadequate products do not keep their approved status. The United States and Brazil could emulate some of the European Union's tactics in their own regulatory processes.

2. Suggested Changes to Pesticide Regulation in the United States and Brazil

There are obvious gaps in the United States and Brazil's regulatory schemes, which stand out even more when compared against a similar entity that has been able to impose strict pesticide regulation without compromising crop production. If the European Union, with the strictest pesticide laws in the world, is considered the standard for regulation, then the United States and Brazil are severely behind. Each country has their own shortcomings, but broad themes such as stricter standards for registration, more emphasis on the environment, adequate enforcement, and proactive steps to improve pesticide use are applicable to both and can be incorporated into their respective legislature and regulations.

The United States already has the framework to successfully regulate pesticides. The role of the EPA is similar to that of the EFSA and European Commission in the EU. The United States mirrors the basics of the European Union's testing and approval process, as well as

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[152] *Economic Outputs for Agriculture*, EUROSTAT (Nov. 16, 2020), https://ec.europa.eu/eurostat/documents/2995521/11519753/5-16112020-AP-EN.pdf/37230ae5-e752-7284-ad9e-53cf23c86b9e [https://perma.cc/XGE8-ZMPW].

[153] Ohio-Ky.-Ind. Water Sci. Ctr., *Pesticides*, U.S. GEOLOGICAL SURV. (Mar. 23, 2017), https://www.usgs.gov/centers/oki-water/science/pesticides?qt-science_center_objects=0#qt-science_center_objects [https://perma.cc/JA3G-WVYZ]; AMTHOR, *supra* note 27, at 1, 11.

[154] Gonzales, *supra* note 58.

having a system of review and ability to cancel registrations. However, this is not enough to control the pesticides that are being approved for use.

The first area of improvement for the United States is the procedure for approving substances. The current process places the responsibility for product testing on the company seeking the registration.[155] It may not be possible or advisable for the EPA to completely take over product testing, especially initially, but the EPA should have more involvement. Utilizing EPA personnel or resources, such as testing facilities or laboratories, would give the EPA better oversight and introduce some uniformity. The EPA can ensure the procedure and results are exactly what the Administrator needs for review, and fewer applications will be sent back with requests for additional information.

Whether the EPA is involved in testing or not, the testing requirements should be more concrete. Basic information such as name, label, directions for use, formula, and test results are required by law, but the Administrator of the EPA can choose what results need to be submitted.[156] A codified baseline for testing requirements would prevent an Administrator from implementing policies that do not adequately protect the general well-being of the public and the environment. This baseline testing requirement should incorporate an overall heightened standard of review. The current standard of review for pesticide testing is determining if a pesticide has unreasonable adverse effects on the environment.[157] To determine unreasonable adverse effects, the Administrator will consider the economic, social, and environmental costs and benefits of using the pesticide.[158] A heightened standard should involve rigorous testing of the substance and how it interacts with other substances, as well as explicitly considering its impact on the environment in a review that is separate from a basic cost-benefit analysis.

Part of the approval process should be a consideration of necessity. As long as a substance meets all the testing requirements, the Administrator must approve it.[159] This phenomenon crowds the

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[155] 7 U.S.C. § 136a(c)(1)(F).
[156] 7 U.S.C. §§ 136a(c)(1)(B)–(F); 7 U.S.C. § 136a(c)(2)(A); 40 C.F.R. §§ 158.33–158.5 (2021).
[157] 7 U.S.C. § 136a(c)(5).
[158] 7 U.S.C. § 136(bb).
[159] 7 U.S.C. § 136a(c)(5).

registration list and makes it more difficult for the EPA to conduct reviews. While the entire European Union has about 400 registered substances, AMVAC Chemical Corporation alone has 409 products registered with the EPA.[160] Rather than approving each company's specific products, the EPA should approve substances and compounds generally, then focus on compliant labeling with each company. Simplifying the list of registrations will streamline the process for approval and help the EPA stay up to date with re-registrations. It makes responding to scientific and technological advances easier because the EPA can broadly approve new products and cancel outdated ones.

It is important that once a substance has been through testing and is approved, that it is regularly revisited. Reviews are required every fifteen years, and, in order to be re-registered, a substance must meet the standard for registration based on current knowledge.[161] Reviewing a product every fifteen years is inadequate for keeping people and the environment safe and hinders progress by keeping potentially outdated products available on the market. A simplified list of registrations would help, but no matter the number of registrations, the EPA needs to shorten the time between mandatory reviews or be more proactive in voluntarily reviewing registrations. If scientific evidence makes it known that a substance is harmful or a better alternative is available, the EPA should flag implicated registrations and begin the process of phasing out those products. When it is time for a mandatory review, the EPA should require more than just a compliance check. They should have baseline requirements for additional, timely studies similar to what is required for initial registration. This process should have a particular focus on the effects of continued use of the pesticide, now that there is at least fifteen years of data, and require another cost-benefit analysis and environmental impact review.

The state of affairs in Brazil is more dire than in the United States. Regulations have been largely abandoned, and there is a flood of pesticides available on the market, both legal and illegal. The country's aggressive, pro-pesticide approach is causing the situation to spiral out of control more quickly than in the United States, as can be seen by the direct and indirect poisoning of Brazilians and the complete lack of

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[160] EUR. COMM'N, *supra* note 135; *Pesticide Product and Label System*, ENV'T PROT. AGENCY, https://ordspub.epa.gov/ords/pesticides/f?p=113:4 [https://perma.cc/LU89-EK23] (last visited Jan. 16, 2022).

[161] 7 U.S.C. § 136a(g)(1)(A)(iv); 40 C.F.R. §§ 155.40(a)(1)–(2) (2021).

resources afforded to Anvisa and the MOE. However, Brazil has the blueprint for adequate regulations in Law 7802. Put very simply, the solution for Brazil is to bring back the standards of Law 7802 and then actually enforce those standards.

In reality, changing the trajectory of Brazil's practices would require a massive overhaul of current conditions and a significant shift in power balances. The first step would be repealing Law 6299 and bringing back the standards from Law 7802. The new law should be updated to address weak spots in the original legislation. For example, Law 7802 and Decree 4074 do not specify appropriate methods of pesticide application. The popular method of aerial spraying should be banned or extremely limited to protect farming communities from poisoning. The law should also include worker protections, such as setting minimum acceptable conditions and mandating appropriate protective gear.

Once sufficient laws are in place, the government must give power and resources back to the MOE and Anvisa. These agencies, working with the MOA, need to have an equal say in pesticide approval and use. Pesticides do not just impact agriculture, so it is imperative that decisions consider health and the environment. Once Anvisa and the MOE are sufficiently funded and included in pesticide registration, Brazil can begin revising how they approve and remove pesticides. Similar to other regulating bodies, Law 7802 required the registration applicant to provide data on the substance but required that it come from a national or international laboratory.[162] This standard should be put in place and be supported by strict specifications for what substances will be allowed. The threshold for registration should be a high one, especially given the number of pesticides that have been rushed through the approval process in recent years. It is also important to address the mass of active registrations. Anvisa, the MOE, and the MOA should create a list of pesticides that can automatically be banned and remove those registrations to thin out the list, then conduct reviews of the remaining pesticides. After this initial review, there needs to be a robust process in place that allows the MOE, the MOA, and Anvisa to review and cancel registrations without as much influence from pro-pesticide lobbyists, government pressure, or lawsuits. Giving explicit criteria for why pesticides will and will not be allowed may help ease some of the

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[162] Lei No. 7.802, de 11 Julho de 1989, Diário Oficial de União [D.O.U.] de 11.07.1989 (Braz.), art. 5 § 1.

outside coercion by holding the government and pesticide manufacturers accountable to a clear standard.

Finally, and maybe most importantly, Brazil needs to put funding and resources into enforcement. A new pesticide law would mean nothing without incentives to follow it. A large part of Brazil's backslide on this front has been due to lack of accountability on every level. Manufacturers, sellers, and farmers are violating the law without any real fear of consequences. Even before the passage of Law 6299, Anvisa and the MOE had been weakened and were unable to properly manage the pesticides that were on the market. Since Law 6299, Anisa and MOE have been further removed from pesticide regulation, and enforcement is now nearly impossible. Once a new pesticide law is introduced, the government needs to encourage compliance by imposing sanctions for violating the regulations. Part of enforcement includes addressing the illegal pesticide trade. The presence of banned substances or substances made by unqualified individuals threatens the well-being of the whole country and would undermine any governmental efforts to get pesticide use under control. The health of Brazilians, both those near the farms and those eating the produce, remain at risk if illegal substances are being used on the crops. There is no protection for the environment and money is pulled out of the economy. Brazil cannot have proper pesticide regulations until they are able to curb the illegal trade.

In addition to making sure the chemical pesticides that are on the market are as safe and effective as they can be, the countries should prioritize non-chemical alternatives. One option is growing organic crops, which means no synthetic fertilizers or pesticides.[163] Organic food uses biopesticides that are derived from living things.[164] Common biopesticides include bacteria, fungi, black pepper, garlic compounds, and insect hormones.[165] These methods can be toxic to specific insects or cause their mating and growth cycles to be disrupted.[166] Another option is biosolarization, a method that uses solar heating and microbial activity to create soil conditions that are lethal to most pests but still safe for human

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[163] *Organic Farming*, ENV'T PROT. AGENCY, https://www.epa.gov/agriculture/organic-farming [https://perma.cc/7EYM-ETGH] (last visited Jan. 16, 2022).

[164] Jane M. Caldwell, *Alternatives to Conventional Pesticides*, INST. OF FOOD TECHNOLOGISTS (May 1, 2020), https://www.ift.org/news-and-publications/food-technology-magazine/issues/2020/may/columns/alternatives-to-conventional-pesticides [https://perma.cc/WL8A-9DXX].

[165] *Id.*

[166] *Id.*

contact and consumption.[167] During summer, biodegradable organic matter is integrated with the soil and insulated with plastic tarps.[168] The conditions activate microorganisms and encourage growth of natural biopesticides in the soil.[169] These methods are not mainstream, but prove there are ways to protect crops without the use of synthetic chemicals. As agricultural leaders, the United States and Brazil should explore non-chemical options and help develop them further.

It is possible for the United States and Brazil to curb their pesticide use and still supply the world with maize. Better control of pesticides will ultimately protect maize by limiting the amount and kinds of chemicals that are introduced into the environment and contribute to climate change. Stricter regulations and standards will also simplify the registration process and drive innovation as manufacturers work to keep their products at the forefront of science and technology. The European Union has demonstrated that comprehensive pesticide laws do not mean an end to the agriculture industry and that it is possible to balance an interest in health, the environment, and the economy. The United States and Brazil are focusing on economic growth, but this distorted approach is not sustainable and both countries need to embrace a holistic method of regulation that will equally prioritize every factor involved.

III. CONCLUSION

Maize is one of the most important crops in the world, and climate change's effects on global production could have potentially detrimental impacts on the global economy and access to food. Climate change is causing shifting temperature and water levels. These conditions compromise growth and foster environments that invite pests and disease. The chosen solution to this problem is use of pesticides, which protect the world's economic and food security interests. However, use of pesticides creates its own set of challenges, including compromising public health and agitating the environment.

The pesticide regulatory scheme in the United States and Brazil is woefully inadequate, especially for the world's two leading exporters of maize. Their current methods for regulation are too heavily focused on

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[167] Christopher Simmons, *Sustainable Alternatives to Pesticides*, U.C. DAVIS (Oct. 26, 2020), https://aghealth.ucdavis.edu/news/sustainable-alternatives-pesticides-reducing-toxic-exposure-and-increasing-soil-health [https://perma.cc/YL9L-SNVZ].

[168] *Id.*

[169] *Id.*

preserving maize yields in the short term, to avoid economic loss or food shortages, with little to no regard for the longer-term implications. These countries should make the pesticide registration process more efficient and registration standards more rigid, so only the most necessary and safe pesticides are available for use. The United States and Brazil also need to prioritize health over profits by looking for alternatives to traditional chemical pesticides. This will help protect the wellbeing of the farmers and consumers, as well as minimize harm to the environment. The European Union offers a model of how countries can impose strict testing and registration standards, proactively update registrations as technology changes, and encourage nonchemical alternatives while still producing adequate crop yields. It is imperative that both countries begin making changes to protect the wellbeing of maize crops, the environment, and people.