# CHLORPYRIFOS: TIME TO BAN THE CONTROVERSIAL PESTICIDE

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Abstract

Chlorpyrifos is an organophosphate pesticide used worldwide. It is used extensively in agricultural sectors, eradicating pests through neurotoxicity. Chlorpyrifos is proven to be harmful to human health, particularly the developmental health of young children, as well as detrimental to non-target organisms such as bees, birds, fish and earthworms. New Zealand's Environmental Protection Agency reassessed chlorpyrifos in 2012, concluding that it was too beneficial to New Zealand's agricultural sector to phase out, proposing instead a new regulatory scheme. The reassessment was widely criticised as being deficient in evidence, external analysis and environmental concern. Similarly, the new regulations that emerged from the reassessment are non-specific, poorly policed and avoidant of user responsibility. Recent studies have proven the failure of the regulatory scheme in protecting the environment, with chlorpyrifos continuing to be found in high concentration in streams, hives and soil. This indicates the need for a complete ban of chlorpyrifos in New Zealand. California, Hawaii and New York have recently proposed a ban on chlorpyrifos in what hopefully indicates the beginning of a global movement.

# *I Introduction to Chlorpyrifos*

## *A Introduction*

For thousands of years, farming and agricultural practices, both within New Zealand and internationally, have relied on the extensive use of pesticides and insecticides as an aggressive form of pest control[1]. Public awareness of the detrimental effects attached to such widespread and often indiscriminate use of these high-toxicity chemicals, rose drastically in the mid 20th century with the publication of Rachel Carson's *Silent Spring*[2]. *Silent Spring,* published in 1962 and now considered an "environmental classic", acted as a radical warning to humanity that haphazard use of pesticides was greatly disrupting critical eco-systems as well as causing detrimental harm to human health[3]. The publication of *Silent Spring* is accredited with initiating international conversations around pesticide regulation, and as such was a formative event in a wider environmental movement. The book largely focused on and ultimately led to the ban of dichlorodiphenyltrichloroethane (DDT) in the 1970's, a highly toxic organochloride that had been developed as an insecticide and used widely in World War II to control malaria and typhus[4].

However, despite such an exponential upsurge in public concern over the harms of pesticides, these highly toxic chemicals continue to be introduced, used and defended world-wide. In New Zealand alone, more than a ton of pesticide active ingredients are used in agricultural practice each year[5]. One of the more controversial pesticides used in modern New Zealand farming practices is chlorpyrifos; a broad-spectrum organophosphate introduced in 1965[6]. Continued and repeated use of chlorpyrifos has been proven to cause health defects in

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[1] John Unsworth "History of Pesticide Use" (10 May 2010) International Union of Pure and Applied Science <https://agrochemicals.iupac.org/index.php?option=com_sobi2&sobi2Task=sobi2Details&catid=3&sobi2Id=31>

[2] Catherine Iorns "Permitting Poison: Pesticide Regulation in Aotearoa New Zealand" (2018) 35 EPLJ 456 at 2.

[3] David Korten "The Time for Postponing Climate Action is Over" *Yes! Magazine* (online ed, 21 January, 2020).

[4] Iorns, n 2, at 3.

[5] RB Chapman "A review of pesticide use on pasture and forage crops in New Zealand" (Agresearch, Lincoln University, 2010).

[6] Meriel Watts "Chlorpyrifos" (July 2013) Pesticide Action Network Asia and the Pacific <http://www.pananz.net/wp-content/uploads/2014/09/Chlorpyrifos-factsheet-.pdf>

children as well as environmental contamination due to its broad-spectrum nature[7]. It is currently on New Zealand's Environmental Protection Authority's Priority Chemicals List, indicating that it needs urgent review, as well as being the subject of a campaign for complete eradication of use by New Zealand's Pesticide Action Network[8]. Chlorpyrifos is currently regulated under the Hazardous Substance and New Organisms Act 1996, however, recent studies on chlorpyrifos' persistence in the environment, as well as compliance and reassessment issues, indicates that the current regulatory scheme is insufficient in controlling the harmful effects of this pesticide[9]. Therefore, a phase out period leading to a complete ban on the use of chlorpyrifos in New Zealand's agricultural sector is called for.

### *B Chlorpyrifos: What is it?*

Chlorpyrifos was first registered as a pesticide in 1965[10]. It is a toxic and broad-spectrum organophosphate pesticide used on a variety of crops, buildings, farm land and animal fixtures[11]. It is one of the most widely used pesticides in global agricultural practice; according to the manufacturer of chlorpyrifos, it is authorised for use in over 100 countries, able to be used on more than 50 agricultural crops and applied to 8.5 million crop acres per year[12]. Chlorpyrifos eradicates insects through neurotoxicity, attacking the same chemical pathway in the body as chemical weapons such as sarin gas, only with lower levels of toxicity.[13] It works by blocking the acetylcholinesterase enzyme, which, when uninhibited, controls acetylcholine, a neurotransmitter that mediates communication between the nerve cells[14]. When this enzyme is blocked, the nervous system is unable to send ordinary signals

[7] Iorns, n 2.
[8] Kimberly Hageman, Christopher Aebig and Kim Luong "Current-use pesticides in New Zealand streams: Comparing results from grab samples and three types of passive samplers" (2019) 254 Environmental Pollution at 3.1.
[9] Hageman, Aebig & Luong, n 8.
[10] Vanessa Schipani "The Facts on Chlorpyrifos" (27 April 2017) FactCheck.Org <https://www.factcheck.org/2017/04/the-facts-on-chlorpyrifos/>
[11] Christensen, K, Harper, B, Luukinen, B, Buhl, K. & Stone, D "Chlorpyrifos: General Factsheet" (2009) National Pesticide Information Centre <http://npic.orst.edu/factsheets/chlorpgen.html>
[12] Christenson, Harper, Luukinen, Buhl & Stone, n 11.
[13] Schipani, n 10.
[14] Watts, n 6.

between nerve cells, leading to an eventual overstimulation of the nervous system, physiological malfunction, and death[15].

Chlorpyrifos is concocted and advertised in liquid, granular and flowable distillates, as well as in pellets, tablets, baits, wettable powders and dusts[16]. When the pesticide was first introduced to the market, it was advertised for agricultural, residential and commercial use; an assertion since retracted due to the proven harm the toxin causes humans. It is now primarily used in agricultural practice. In agriculture, chlorpyrifos is commonly used as a foliar spray or alternatively, it is integrated directly into the soil before planting begins.[17] Health and environmental concerns attached to the use of chlorpyrifos are primarily focused on the broad-spectrum nature of the pesticide as well as its persistence in the environment. Chlorpyrifos is shown to break down relatively slowly in soil and run-off waterways, having the potential to toxicologically effect non-target organisms who are exposed to the pesticide. Similarly, 'broad-spectrum', whilst commercially attractive for versatility, also results in non-target organisms being harmed by the neurotoxicity effects of the pesticide[18]. These health and environmental concerns surrounding chlorpyrifos are not revolutionary or circumstantial. Definitive studies conducted early in the 2000's called attention to the complex and problematic nature of the pesticide for both humans and environmental sustainability.

## *II Health and Environmental Concerns*

### *A Human health concerns*

Chlorpyrifos is presently classified as moderately toxic to human health[19]. Chlorpyrifos in its pure form is not considered toxic to humans, but when the body attempts to break it down, a

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[15] Christenson, Harper, Luukinen, Buhl & Stone, n 11.

[16] Elizabeth John & Jisha Shaike "Chlorpyrifos: pollution and remediation" (2015) 13 Environ Chem Lett 269 at 270.

[17] Meriel Watts "Chlorpyrifos as a possible global persistent organic pollutant" (2012) Pesticide Action Network North America <file:///Users/abbyhutchison/Downloads/SSRN-id3270393.pdf>

[18] Iorns, n 2, at 41.

[19] "Priority Chemicals List" Environmental Protection Authority <https://www.epa.govt.nz/industry-areas/hazardous-substances/chemical-reassessment-programme/priority-chemicals-list/>

toxic form of the organophosphate is created, called the chlorpyrifos oxon.[20] The chlorpyrifos oxon binds permanently to enzymes which mediate the messages sent between the nerve cells. When this happens at a rapid pace and on a large scale, the functionality of the body's nerves and muscles begins to fail.[21] High levels of exposure to chlorpyrifos, such as what farmers would endure in the routine of spraying the pesticide, symptomatically presents as nausea, dizziness, headaches, and in serious cases, loss of coordination or consciousness[22]. However, it is not exclusively farmers who are exposed to chlorpyrifos poisoning; its effects are proven to be dangerously far-reaching. Humans are exposed to the pesticide a multitude of ways, primarily through residue left on fruit and vegetables, contamination of drinking-water and toxic spray drift from large-scale agricultural spraying[23]. Children are exposed to relatively higher levels of chlorpyrifos due to higher hand to mouth contact and a higher consumption of fruit and water for their body size compared to adults[24]. Chlorpyrifos can be absorbed by humans orally, dermally or through inhalation[25]. Biomonitoring in the United States between 1999 and 2000 showed that 94% of those assessed had traces of chlorpyrifos in their bodies[26]. Such a high exposure rate indicated a more drastic problem that initially conceived, leading to a reform in US pesticide regulation in the early 2000's, phasing chlorpyrifos and other organophosphates out of residential use.

The seriousness of chronic exposure to chlorpyrifos was first systematically studied by a team of researchers at Columbia's Center for Children's Environmental Health beginning in the year 2000. The study looked at the relationship between prenatal exposure to chlorpyrifos and neurodevelopment by comparing two identical groups of pregnant women, one of which had been exposed to household chlorpyrifos in pregnancy, whilst the latter had not[27].The

[20] Christenson, Harper, Luukinen, Buhl & Stone, n 11.
[21] Christenson, Harper, Luukinen, Buhl & Stone, n 11.
[22] Xindi Hu "The most widely used pesticide, one year later" (17 April 2018) Harvard University: Science in the News < http://sitn.hms.harvard.edu/flash/2018/widely-used-pesticide-one-year-later/>
[23] Earth Justice "Chlorpyrifos: The toxic pesticide harming our children and environment" (2020) EarthJustice.Org <https://earthjustice.org/features/what-you-need-to-know-about-chlorpyrifos>
[24] Earth Justice, n 23.
[25] Christensen, K, Harper, B, Luukinen, B, Buhl, K. & Stone, D "Chlorpyrifos: Technical Factsheet" (2009) National Pesticide Information Centre <http://npic.orst.edu/factsheets/chlorpgen.html>
[26] Watts, n 6.
[27] Virginia Rauh "Discussion of analyses of prenatal chlorpyrifos exposure and neurodevelopmental outcomes" (2004) Columbia Center for Children's Environmental Health <https://archive.epa.gov/scipoly/sap/meetings/web/pdf/rauh.pdf>

study found that the children who had been exposed to chlorpyrifos in the womb, were on average, smaller, had slower reflexes, poorer mental development, inferior verbal IQ and a higher risk of increasing a development disorder as an infant, than other children their age[28]. Multiple subsequent, follow up and meta-analysis studies have provided strong evidentiary support for the harm that chlorpyrifos exposure has on neurodevelopment, particularly in children[29]. A study published in the Environmental Health Perspectives in 2014 found that close proximity to organophosphates, such as chlorpyrifos, during pregnancy resulted in a 60% increased risk of autism spectrum disorder[30]. A further study conducted in China in 2017, similarly found that prenatal exposure to organophosphates resulted in decreased motor skills and mental deficits, particularly in young girls[31]. Therefore, the use of chlorpyrifos in such large quantities causes great risk to families, particularly children, in rural communities.

### *B Environmental concerns*

As well as high human toxicity, chlorpyrifos is additionally harmful to the environment and toxic to beneficial environmental organisms. Chlorpyrifos is considered to be moderately persistent in the environment as it binds strongly to soil, becoming relatively immobile[32]. Chlorpyrifos enters the soil through direct application or as a consequence of foliar spraying, and absorbs strongly into soil particles, boasting a half-life from 7 days to over a year dependent on rate of application, soil type and climate conditions.[33] For example, it has been found that dissipation of chlorpyrifos from soil occurs faster in tropical conditions, therefore decreasing the half-life of the organophosphate, but occurs much slower in arctic conditions where persistence will be much greater.[34] This is a viable issue as chlorpyrifos residue has

[28] Rauh, n 27.
[29] Hu, n 22.
[30] Shelton, Geraghty & Tancredi "Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: the CHARGE study" (2014) 122 Environ Health Perspect 266.
[31] Silver, Shau & Zhu "Prenatal naled and chlorpyrifos exposure is associated with deficits in infant motor function in a cohort of Chinese infants" (2017) 106 Environment International 248.
[32] Extension toxicology network "Chlorpyrifos" (1993) EXTOXNET <http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/chlorpyrifos-ext.html>, at "Soil".
[33] John & Shaike, n 16, at 271.
[34] Watts, n 17, at 7.

been found in significant levels in arctic regions since 1972, presumably due to long-range global transport.[35]

High persistence records and long-range environmental transfer are of particular environmental concern due to the toxic effect that chlorpyrifos is found to have on non-target organisms, particularly birds and bees. Recent studies have shown chlorpyrifos to be highly toxic to birds and bees, even in small doses. A recent study examined chlorpyrifos levels in bees collected from Otago, New Zealand and the effect that higher levels of chlorpyrifos had on the learning ability of the bees[36]. It was found that bees who had been exposed to high levels of chlorpyrifos suffered severe detriment to their olfactory memory formation and retrieval system, a vital part of their behavioural patterns during pollination[37]. This therefore threatened their ability to successfully pollinate, subsequently threatening survival of pollination dependent plants[38]. It is also moderately to highly toxic for many species of birds including ducks, chickens and pigeons. It can result in birth defects, fewer offspring, flying defects and death[39]. Other non-target organisms that are often harmed by chlorpyrifos poisoning include earthworms, insects and exposed mammals.

When chlorpyrifos absorbs into soil, it does not separate readily from soil into water, however it does enter waterways through spray drift, eroded soil or run-off of contaminated soil[40]. The half-life of chlorpyrifos in water is anywhere from 35 to 100 days dependent on water pH and temperature[41]. In a 2019 study looking at pesticide presence in a variety of New Zealand streams, two or more pesticides were found to be present in 78% of cases with chlorpyrifos being found in the highest concentration[42]. The high levels of chlorpyrifos present in New Zealand's streams is decidedly problematic due to the high toxicity of

[35] Watts, n 17, at 26.
[36] Urlacher, Monchanin & Riviere "Measurements of chlorpyrifos levels in forager bees and comparisons with levels that disrupt honey-bee odor-mediated learning under laboratory conditions" (2016) 42 Journal of Chemical Ecology 127.
[37] Urlacher, Monchanin & Riviere, n 36.
[38] The Ecologist "Chlorpyrifos may threaten survival of forager bees" (11 March 2016) The Ecologist < https://theecologist.org/2016/mar/11/chlorpyrifos-may-threaten-survival-forager-bees>
[39] Christenson, Harper, Luukinen, Buhl & Stone, n 11, "Birds, fish, and other wildlife".
[40] Extension toxicology network, n 32, at "Water".
[41] Extension toxicology network, n 32, at "Water".
[42] Hageman, Aebig & Luong, n 8.

chlorpyrifos for aquatic invertebrates, freshwater fish and other marine organisms[43]. It can cause delayed motor-skills, maturation and physical growth, as well as reproductive impairments and immune system failure in several aquatic species[44]. It causes genotoxicity; the damaging of DNA structure, and injurious mutagenicity; genetic alteration, in fish.[45] Further, there is evidence that chlorpyrifos bioaccumulates in the tissue of aquatic species, meaning that it builds up in the tissue of fish and other marine animals, therefore increasing the risk of long-term toxicological effects.[46]

## *III Reassessment of chlorpyrifos in New Zealand: and unsatisfactory process*

### *A The inaccessibility of the pesticide reassessment in New Zealand*

Chlorpyrifos is currently regulated under the *Hazardous Substances and New Organisms Act (HSNO) 1996*, which came into force on the 2nd of July 2001. The aim of this Act was to introduce an effective and collated regulatory scheme that controlled potentially hazardous substances, based on the risk characteristics of these substances.[47] Pesticides came under the domain of this Act in 2003. The HSNO gives power to the Environmental Protection Authority (EPA) to assess hazardous substances and new organisms in cases or approval, reassessment or risk classification.[48] Once a hazardous substance has been approved under this Act, it is given a hazard classification, and then is able to be manufactured and imported relatively freely.[49] Chlorpyrifos is an approved substance in New Zealand under the HSNO.

Under the HSNO, anyone is able to request that the EPA reassess an approved pesticide or other hazardous substance.[50] There are four grounds upon which a pesticide can be reassessed in New Zealand; the emergence of significant new information relating to the effects of the

[43] Christenson, Harper, Luukinen, Buhl & Stone, n 25, at "Fish and Aquatic Wildlife".
[44] Pesticide Action Network Aotearoa New Zealand "Reassessment of organophosphate and carbamate insecticides" (January, 2013) <https://www.epa.govt.nz/assets/FileAPI/hsno-ar/APP201045/cbd61fbe75/APP201045-Submission-102658-M-Watts-PAN-ANZ.pdf> at 19.
[45] Pesticide Action Network Aotearoa New Zealand, n 44, at 11.
[46] Watts, n 17, at 12.
[47] Iorns, n 2, at 25.
[48] Environmental Protection Authority Act 2011.
[49] Iorns, n 2, at 25.
[50] Hazardous Substances and New Organisms Act 1996, s 62(1).

substance, changes in workplace safety regulations, a similar substance with lesser adverse effect has become available or the emergence of information relating to a change in the quantity of the substance being manufactured or imported.[51] These grounds are relatively restrictive, and fail to take into account international treatment of similar substances; a consideration that should be of high importance in the current day where environmental degradation is an international concern.[52] There are several further obstructions to the current reassessment process, culminating in an unfriendly and unsatisfactory procedure that is limited in its practical use. Perhaps most significant, is the financial demand of reassessment, a demand which currently lands on the applicant themselves, resulting in very few reassessment cases being pushed forwards.[53] This ultimately means that many pesticides and other hazardous substances are currently approved based on initial assessment information that is no longer conducive with modern environmental conditions.[54] The Ministry for the Environment, back in 2002, released a report calling for an increased number of publicly funded reassessments for this reason.[55]

### *B NZ Environmental Protection Agency reassessment of chlorpyrifos in 2013*

Chlorpyrifos was reassessed by the EPA in 2013 as a part of the large-scale reassessment of 30 different organophosphate and carbamate insecticides, and their position in New Zealand.[56] The reassessment was authorised on the ground of new information having become available on the harmful effects of the substances in question.[57] The EPA outlined their process as consisting primarily of wide scale date collection including extensive risk assessment on both human and environmental toxicology. They further welcomed submissions from external parties on the costs and benefits of each pesticide and the viability

[51] Hazardous Substances and New Organisms Act 1996, s 62(2).

[52] Iorns, n 2, at 33.

[53] Ministry for the Environment "Towards a Pesticides Risk Reduction Policy for New Zealand" (2002) <https://www.mfe.govt.nz/sites/default/files/towards-pesticide-risk-reduction-apr02.pdf>

[54] Ministry for the Environment, n 53.

[55] Ministry for the Environment, n 53.

[56] Environmental Protection Authority "Application for the reassessment of a group of hazardous substances" (June 2013) <https://www.epa.govt.nz/assets/FileAPI/hsno-ar/APP201045/989dca5648/APP201045-APP201045-Decision-Amended-with-s67As-and-APP202142-2015.07.28.pdf>

[57] Environmental Protection Authority, n 56, at 3.2.

of any proposed regulatory changes.[58] The overall risks and benefits of each pesticide were then weighed up and a proposal was made as to what pesticides should be kept in agricultural circulation throughout New Zealand.

Chlorpyrifos was one of very few of the reassessed pesticides, that the EPA proposed to keep in use in New Zealand; a decision which has been heavily criticised. The EPA's reassessment proposal acknowledged the harm that chlorpyrifos posed to human health and the wider environment, specifically the harm it causes bees, birds and other environmentally beneficial organisms. Despite this, the EPA considered chlorpyrifos to be too extensively valuable in New Zealand's agricultural sector to phase out completely. Chlorpyrifos was labelled as being of "critical importance" to horticulture and pastural maintenance, such that the economic and agricultural benefits of using the pesticide outweighed the proven harms[59] The EPA proposed instead to place more stringent control in place around the use of the pesticide in an attempt to alleviate harm.[60]

### *C A problematic reassessment of chlorpyrifos*

The EPA's reassessment of, and decision to maintain, chlorpyrifos has been criticised as being unsatisfactory. It has been accused of being deficient in robust evidentiary support, independent advice as to benefits and alternatives to chlorpyrifos, and recognition of the ecological detriment that chlorpyrifos is causing currently and will cause in the future. Dr Meriel Watts, an expert in pesticides and agricultural science, stated that due to the deficits in the assessment process, it could only be considered a partial analysis.[61] The Pesticide Action Network of Aotearoa New Zealand (PANANZ) was particularly strong in their dissent to the EPA's proposal for the treatment of chlorpyrifos.[62]

PANANZ submitted that the EPA decision failed to investigate thoroughly enough, the detrimental effects of chlorpyrifos, both for humans and the environment. Of particular concern was the lack of focus on the detriment chlorpyrifos causes developmental

[58] Environmental Protection Authority, n 56, at 3.7.
[59] Environmental Protection Authority, n 56, at 11.16.
[60] Environmental Protection Authority, n 56, at 15.24.
[61] Iorns, n 2, at 45.
[62] Pesticide Action Network Aotearoa New Zealand, n 44.

progression in children.[63] The EPA reassessment focused strongly on the acceptable-daily-intake (ADI) value of chlorpyrifos in determining the safety of the pesticide for human exposure. The emphasis placed on the ADI is problematic as it is not child-specific and therefore not protective of children or unborn fetus'.[64] The Californian EPA in direct contradiction, reassessed chlorpyrifos in 2010, focusing strongly on the developmental effects that exposure can have on children, calculating a child-appropriate ADI 30 times lower than that used by New Zealand's EPA, therefore producing an assessment that was more protective of children.[65] This persuasively indicates that the EPA's decision lacked recognition of all the health effects attached to chlorpyrifos, as well as consideration of international regulation.

Further, the EPA's reassessment of chlorpyrifos relies too heavily on the needs submitted by the various agricultural sectors, while simultaneously failing to seek out independent analysis on this issue. This facilitated a proposal that has been criticised for being "inclined to pay greater attention to the need of users, the perceived needs of users, than it is to the actual protection of the environment".[66] PANANZ argued that the excessive list of needs submitted by users of chlorpyrifos should be considered with a degree of doubt, as the users of chlorpyrifos are likely to exaggerate the daily uses of the pesticide to ensure it stays on the market.[67] There is also evidence that the 'critical use list' for chlorpyrifos that has been provided by various agricultural sectors is vague, outdated and fails to take into consideration naturally occurring bio-controls such as predators or parasites.[68]

The last major problematic aspect of the EPA's reassessment of chlorpyrifos is the lack of information in the resulting proposal on safe and effective alternatives, as well as a lack of general evidence on the necessity of chlorpyrifos use. The proposal to retain chlorpyrifos in New Zealand's market was based largely on the perceived benefits of the pesticide and the detriment to horticulture in New Zealand if it were to be phased out.[69] However, the proposal

[63] Pesticide Action Network Aotearoa New Zealand, n 44, at 3.
[64] Pesticide Action Network Aotearoa New Zealand, n 44, at 4.
[65] Pesticide Action Network Aotearoa New Zealand, n 44, at 3.
[66] Meriel Watts – Auckland Hearing transcription at 101.
[67] Pesticide Action Network Aotearoa New Zealand, n 44, at 11.
[68] Pesticide Action Network Aotearoa New Zealand, n 44, at 13.
[69] Environmental Protection Authority, n 56.

lacks evidence that supports the notion, that the removal of chlorpyrifos and its replacement with an alternative pest control means, would cause decreased crop production and pest overrun on farms.[70] It further fails to outline potential alternatives to chlorpyrifos or invest in any research into the efficacy of available alternatives. The inclusion of such an analysis would have likely decreased the overwhelming weight placed on the perceived benefits of chlorpyrifos use, leading to a more balanced conclusion on the future of chlorpyrifos in New Zealand, potentially in the way of a complete eradication as opposed to increased regulation.

## *IV The current regulatory scheme fails to solve the problem*

### *A Current regulation following reassessment*

Following the EPA's reassessment of chlorpyrifos, a new, supposedly more stringent, set of regulations were enacted for use of the organophosphate, enforceable from the 1st of July 2015. The new regulations allege protection of "your health, the health of others and the environment".[71] It is now regulation that you must be an approved handler when moving, applying or dealing with chlorpyrifos in any form, or alternatively be under the supervision of an approved handler.[72] Handling of liquid chlorpyrifos requires the use of full personal protection equipment and granular chlorpyrifos additionally requires full respiratory protective equipment.[73] There is a lesser maximum application rate per hectare of farmland, as well as instruction to thoroughly cover granules of chlorpyrifos immediately after application with soil, specifically to "protect birdlife".[74] Similarly, there is an ambiguous requirement to "not spray chlorpyrifos where bees are foraging", in an attempt to reduce toxicity effects on local bee populations.[75] In terms of human protection, the EPA has specified a mere notification requirement, under which airborne application of chlorpyrifos must be prefaced with a notice to surrounding landowners of the date and time of

[70] Pesticide Action Network Aotearoa New Zealand, n 44, at 14.
[71] Environmental Protection Authority "Safely using insecticides containing chlorpyrifos on plants" (October, 2013) <file:///Users/abbyhutchison/Downloads/2023WKS-2-hazardous-substances-chlorpyrifos-insecticide-guidance.pdf>.
[72] Environmental Protection Authority, n 71.
[73] Environmental Protection Authority, n 71, at "Wear the right safety gear".
[74] Environmental Protection Authority, n 71, at "Granular chlorpyrifos".
[75] Environmental Protection Authority, n 71, at "Chlorpyrifos is toxic to the environment".

application.[76] Lastly, the new regulatory scheme "prohibits" anyone from entering an area where liquid chlorpyrifos has been applied for a minimum time of 24 hours, lest they are wearing protective equipment[77]

### *B Compliance concerns with current regulatory scheme*

The new regulatory rules attached to chlorpyrifos are, despite the outwardly strict guidelines, and the underlying intention to protect the environment, largely unsatisfactory. They are non-specific, they shift responsibility away from users and there is a lack of compliance policing that renders the scheme as essentially, voluntary. The wording of the regulation is particularly problematic due to the vagueness with which it attempts to direct users of chlorpyrifos in protective measures. Phrases such as "don't spray when it is windy," are highly ambiguous and as such open to wide interpretation. It denotes a lack of certainty that is likely to lead to dismissiveness of such statements by chlorpyrifos users. Further, the regulatory scheme as a whole transfers responsibility away from users. The notification requirement particularly, allows users to act to a minimal capacity to ensure human safety before placing a larger responsibility on those who have been notified, to act in protection of their own safety. This is largely counterintuitive as the regulations are directed at users, not the exposed and as such should place larger responsibility on users to proactively prevent high levels of exposure.

Lastly, there is a lack of compliance policing attached to the regulatory scheme, which lessens the efficiency of the scheme. The stricter regulations such as application rate, time and area are not monitored firmly by the EPA or other external policing organisation, and as such there is a lack of consequence for non-compliance that encourages indolence in users. PAN ANZ argues that due to this reason, the regulations for chlorpyrifos use cannot be relied on to protect bees, birds or other at-risk organisms.[78] Such a flawed scheme proves the difficulty of regulating chlorpyrifos effectively, signifying the necessity of a full ban.

### *C Environmental protection failure of current regulatory scheme*

[76] Environmental Protection Authority, n 71, at "Liquid chlorpyrifos",
[77] Environmental Protection Authority, n 77.
[78] Pesticide Action Network Aotearoa New Zealand, n 44, at 17.

The theoretical deficiencies in the regulation of chlorpyrifos in New Zealand, as well as the high toxicity of the organophosphate, mean the environment continues to suffer from its high-level use. An upsurge in the availability of environmental data collected in recent years, suggests that the current regulatory scheme is failing in its fundamental goal of environmental protection. This has ensured that chlorpyrifos remains on EPA New Zealand's priority chemical list with a high environmental risk score and moderate human risk score, indicating that its position in New Zealand as an approved substance needs urgent review.[79]

Notably, there is evidence that chlorpyrifos meets some of the criteria under the Stockholm Convention, to be officially classified as a Persistent Organic Pollutants (POP). The Stockholm Convention defines POPs as substances that are widely distributed, long lasting and toxic to humans and environmental organisms.[80] The purpose of the Convention is to protect environmental and human health internationally, from the substances that meet this definition by banning production, distribution and domestic use.[81] A paper produced by PAN North America in 2012 reported that chlorpyrifos met this definition on multiple fronts; it is shown to be highly persistent in Arctic conditions, persistent in freshwater sediment and soil in some conditions and there is emerging evidence of bioaccumulation in aquatic organisms.[82] New Zealand is one of 180 countries committed to this Convention and it was ratified into domestic law in 2004.[83] However, despite chlorpyrifos meeting and exceeding selected criteria for classification as a POP, New Zealand is yet to phase out its use.

Further, several recent studies relating to pesticide contamination in New Zealand have found evidence of chlorpyrifos' continued presence and harm in the environment. A study conducted in 2019 on the persistence of pesticides in New Zealand's waterways found high concentrations of chlorpyrifos present in the majority of tested streams.[84] The study took samples from 36 different streams across 4 different agricultural regions in New Zealand and found that chlorpyrifos residue was detected in 83% of samples and often yielded the highest

[79] Environmental Protection Authority, n 18.

[80] Ministry for the Environment "Stockholm Convention on Persistent Organic Pollutants" (April, 2019) <https://www.mfe.govt.nz/more/international-environmental-agreements/multilateral-environmental-agreements/stockholm>

[81] Ministry for the Environment, n 81, at "About the convention".

[82] Watts, n 17, at 25.

[83] Ministry for the Environment, n 81, at "What are Persistent Organic Pollutants".

[84] Hageman, Aebig & Luong, n 8.

concentration of all tested-for pesticides.[85] This is particularly concerning due to the proven detriment that chlorpyrifos causes aquatic organisms. The authors of this study believed this result to be of high environmental concern, suggesting strongly that chlorpyrifos use in agricultural practice be "further investigated".[86] Similarly, the New Zealand based study on chlorpyrifos' effect on bee populations, which found chlorpyrifos to be highly toxic to local bee populations, was conducted in 2016, a year after the implementation of the new regulatory scheme. This study found chlorpyrifos to be present at 17% of the sites sampled across the Otago region, suggesting that the EPA regulations specific to bee-protection, enacted only a year earlier, are not producing the desired result.

Overall, both of these studies signify a failure of chlorpyrifos regulations to successfully protect the environment from the toxic organophosphate. Despite the new regulation, it continues to be found in high concentrations in various environmental sectors and as such continues to threaten environmental health and the health of highly exposed organisms, contributing to the notion that a full-ban is necessary moving forward.

## *V Complete ban and alternative options*

### *A Why a complete ban is a necessary and viable option?*

In light of regulation failure, in order to decisively ensure environmental and health protection against chlorpyrifos, the highly toxic organophosphate should be banned following a relatively short phase-out period in which alternative pesticides can be successfully introduced. A phase out period of 1 month for domestic use of chlorpyrifos and 18 months for agricultural use of chlorpyrifos was proposed by PAN ANZ in their response to the EPA's reassessment of chlorpyrifos.[87] This relatively short phase-out period was also supported by Dr. Meriel Watts in her reassessment application.[88] A short-phase out period is considered to be vital for chlorpyrifos due to the wide-ranging and severe health and environmental effects

[85] Hageman, Aebig & Luong, n 8.
[86] Hageman, Aebig & Luong, n 8, at 3.2.
[87] Pesticide Action Network Aotearoa New Zealand, n 63 at 3.3.
[88] Hearing with Meriel Watts (Damian Stone, OPC Hearing, 7 March 2013) <https://www.epa.govt.nz/assets/FileAPI/hsno-ar/APP201045/dc054e1474/APP201045-HEARING-Trascription-7-March-Auckland-hearing-APP201045.pdf> at 117.

attached to use of the organophosphate. The harm that chlorpyrifos poses to bees, aquatic life and birds is a danger to future environmental sustainability, and therefore, eradication of use must be as quick as practicality allows. For example, if bee colonies continue to be targeted by toxic pesticides such as chlorpyrifos, fewer bees will survive to successfully pollinate vital plant species, leading to a large-scale loss of plant-life, and ultimately a decrease in global availability of food.[89] Similarly, a decrease in bird-life due to high-rate pesticide use would mean the elimination of an over-looked biological pest-control, leading to a decrease in crop production and lower food availability.[90] Such consequences are not abstract theorisation, but proven costs of environmental disregard, and as such are a strong factor in favour of a global ban of chlorpyrifos and other toxic pesticides.

The banning of chlorpyrifos is not a drastic proposal, as proven recently by California, America's top food-production state, announcing that they were banning the use of chlorpyrifos in domestic, commercial and agricultural sectors. It was announced in October of 2019 that all sales of chlorpyrifos to Californian farmers would be banned from February 2020, and general possession would be banned from December 2020.[91] The decision was largely motivated by the publication of recent studies that showed chlorpyrifos to be the cause of neurological and developmental defects in children, particularly those living close to agricultural fields.[92] California is not alone in its treatment of chlorpyrifos as a dangerous substance; the organophosphate was banned in Hawaii in 2018,[93] and recently New York looks to follow suit with a regulatory phase out period to be put in place in 2020, leading to

[89] "What would happen if bees went extinct" BBC <https://www.bbc.com/future/article/20140502-what-if-bees-went-extinct>

[90] Julia Trafford "Imagine a world without birds" (19 July 2016) Garden Bird <http://voice.gardenbird.co.uk/imagine-a-world-without-birds/>

[91] Gina Solomon "Why California is banning chlorpyrifos: a widely used pesticide: 5 questions answered" (24 January 2020) The Conversation <http://theconversation.com/why-california-is-banning-chlorpyrifos-a-widely-used-pesticide-5-questions-answered-130115>

[92] California Environmental Protection Agency "Agreement reached to end sale of chlorpyrifos in California by February 2020" (9 October, 2019) Department of Pesticide Regulation <https://calepa.ca.gov/2019/10/09/press-release-agreement-reached-to-end-sale-of-chlorpyrifos-in-ca-by-feb-2020/>

[93] Dominique Mosbergen "Hawaii becomes first state to ban widely-used pesticide found to be harmful to kids" (14 June 208) HuffPost <https://www.huffpost.com/entry/chlorpyrifos-ban-hawaii-pesticide>

complete eradication in July 2021.[94] This indicates that banning chlorpyrifos from use is able to be done successfully without any long term or detrimental effect on crop-production. Further, it indicates that the benefits of chlorpyrifos are not considered to outweigh the negatives in these states, a potential consideration for New Zealand's EPA moving forward.

Finally, a ban on chlorpyrifos is unlikely to significantly effect crop-production in New Zealand due to the availability of alternative forms of pest-control. Alternatives can include safer chemicals, biopesticides and biological controls. Biopesticides are pesticides which are derived from natural materials and designed to control pests through specific biological effects.[95] A wide range of biopesticides have been manufactured, tested and used in alternative agriculture. Biological control is the management of pests using natural enemies; it is often used as part of a wider pest strategy and involves active human involvement, whilst still imitating organic biological process.[96] These alternatives are environmentally safe and economically effective, and with active input from the EPA and other governmental organisations, could be easily implemented and regulated. However, as Dr. Meriel Watts states in her submission on chlorpyrifos, the availability of alternatives should be largely irrelevant to the assessment of the overwhelming problem, this being the unequivocal harm that is being done to the environment.[97]

## *VI Conclusion*

In conclusion, New Zealand needs to ban chlorpyrifos from all use, at the end of a relatively short phase-out period. Chlorpyrifos is proven to be toxic to humans, bees, birds, earthworms, fish and other aquatic life. It is persistent in the environment under certain conditions and has been shown to reach the Stockholm Convention criteria for classification as a Persistent Organic Pollutant. Current regulation of chlorpyrifos in New Zealand is based

[94] Governor Andrew M. Cuomo "Governor Cuomo directs DEC to ban the use of chlorpyrifos" (10 December 2019) New York State <https://www.governor.ny.gov/news/governor-cuomo-directs-dec-ban-use-chlorpyrifos>
[95] Sporleder & Lacey "Biopesticides" (2013) Science Direct <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biopesticide>
[96] Anthony Shelton "Biological Control" Cornell University: School of Agriculture and Life Sciences < http://theconversation.com/why-california-is-banning-chlorpyrifos-a-widely-used-pesticide-5-questions-answered-130115>
[97] Meriel Watts, n 89, at 101.

on a flawed and incomplete reassessment and as such is non-satisfactory in protecting human health and environmental sustainability. Recent studies have shown chlorpyrifos to still be present in large quantities in streams, beehives and soil, indicating that the regulatory scheme is failing in its protection of these ecosystems. This leads to the conclusion that New Zealand needs to ban chlorpyrifos to decisively ensure such protection. A ban of chlorpyrifos has been successfully implemented in several US states, indicating both the international treatment of chlorpyrifos as a dangerous substance, and the viability of a complete ban. To allow chlorpyrifos to continue to be used would be hugely detrimental for New Zealand's environment in the future, leading to a decrease in biodiversity, crop-production and food availability.

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