



# FRUITS AND VEGETABLES: GLOBAL VALUE CHAINS EXPLAINED

BRIEFING NOTE SERIES

## Briefing Note 3 |

### Fruits and vegetables: the safe cornerstone of healthy and nutritious diets

The fresh produce industry provides a crucial contribution to global health by bringing delicious and healthy fruits and vegetables from farms to consumers.

In this briefing note, we will address uncertainties around residues of agrochemicals in fruits and vegetables, showing that our products are not only tasty and nutritious—they are also perfectly safe to eat. In nearly every country across the world, regulators exert tight control over the use of agrochemicals through comprehensive legislative frameworks for their registration and application. Extremely thorough, science-based evaluations of the toxicity of agrochemicals ensure that these products are safe and effective before reaching the market.

Meanwhile, rigorous risk assessment processes guarantee that the level of chemical residues allowed to remain on or in fruits and vegetables does not cause any harm to even the most vulnerable consumers, such as children or pregnant women.

*Harmonizing residue limits for agrochemicals across countries is critical to reduce trade barriers caused by diverging national regulations. Inconsistent and differing national limits create high compliance costs and significant uncertainty for fresh produce growers and traders globally.*

# WHY DO GROWERS USE AGROCHEMICALS?

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The fresh produce industry is at the heart of global food security, ensuring a steady supply of fruits and vegetables to meet the demand for safe and healthy food of a growing world population. To do this, fruit and vegetable growers across the world rely on agrochemicals—natural and synthetic—to help protect their crops from pests and diseases, and to increase productivity. **Agrochemicals play a crucial role in protecting agricultural productivity and ensuring food quality and safety:**

- 📍 **Crop protection:** growers use plant protection products (herbicides, insecticides, and fungicides) to help control the thousands of weed species, harmful insects, and plant diseases that can significantly reduce crop yields.
- 📍 **Productivity:** fertilizers and soil improvement agents are used to support plant development and enhance soil quality. They help farmers grow more food on less land and increase overall productivity.
- 📍 **Food quality:** agrochemicals help maintain the aesthetic and nutritional quality of fruits and vegetables, making them more appealing to consumers and prolonging shelf life.
- 📍 **Food safety:** the use of agrochemicals decreases exposure to food contaminated with harmful micro-organisms and naturally occurring toxins, preventing food-related illnesses.
- 📍 **Loss prevention:** agrochemicals protect harvested produce during storage from contamination by pests and harmful micro-organisms.
- 📍 **Maintain food supply and stabilize prices:** by protecting crops from pests and diseases and supporting plant health, the use of agrochemicals leads to higher yields and more stable supplies, which in turn leads to more stable prices in retail outlets.

**The use of agrochemicals enables farmers to produce safe, quality fruits and vegetables at affordable prices, thus providing a crucial contribution to human health and well-being.**

In addition, the enhanced crop quantity and quality that results from the use of agrochemicals translates to increased revenue for farmers and contributes to the economic stability of agricultural communities. Without agrochemicals, overall production would decline and many of the fruits and vegetables enjoyed by consumers worldwide would be in short supply. A recent study of European farming systems found that without the use of pesticides, there would be a 78 percent loss of fruit production and a 54 percent loss of vegetable production.<sup>i</sup> Another study in the United States of America estimates that without fungicides, yields of most fruit and vegetables would fall by 50 to 90 percent.<sup>ii</sup> And without the agrochemicals used to protect fruits and vegetables against pests, fungi and bacteria after they are harvested, shelf life and quality would be compromised, and food losses and waste would increase.

## **Climate change exacerbates growers' need for plant protection solutions**

Unprecedented extreme weather events and climate change add pressure on producers to rely on agrochemicals to protect their yields and prevent product loss. Rising temperatures, altered precipitation patterns, and extreme weather events directly influence the life cycles, population dynamics, and geographical distribution of plant pathogens and pests. Since temperature is the most important environmental factor affecting insect population dynamics, it is expected that global climate warming will expand the geographical range and increase the populations of many agricultural pests and diseases. Milder winters allow more pests to survive, and warmer temperatures can accelerate their life cycles and increase the frequency of outbreaks.<sup>iii</sup> Meanwhile, stress from higher temperatures and changing rainfall patterns makes crops more vulnerable to pests and diseases, increasing the need for chemical interventions.<sup>iv</sup> In addition, warmer climates can lead to extended plant growing seasons and therefore more opportunities for weeds and pests to proliferate. At the same time, some crop protection products may become less effective in warmer conditions or when applied more frequently, forcing farmers to apply more of them, or more often.

# REGULATORS EXERT TIGHT CONTROL OVER THE USE OF AGROCHEMICALS

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The use of agrochemicals, while critical in safeguarding agricultural productivity and guaranteeing the quality and safety of fresh produce, can present significant challenges and risks. The overuse and misuse of these products may pose significant risks to both the environment and to human health. Environmental risks from the misuse of agrochemicals include the depletion of beneficial soil organisms, alteration of water quality, and negative impacts on nearby wildlife and biodiversity. In humans, direct exposure (through occupational, agricultural, and household activities) and indirect exposure (via the food chain) to agrochemicals have been linked to conditions such as asthma, allergies, cancer, neurological disorders, infertility, hormone disruption, and birth defects.<sup>1</sup> Risks are especially high for farm workers handling these chemicals without proper personal protective equipment or training.

It is for these reasons that regulators exert tight control over agrochemical use through comprehensive legislative frameworks for registration, labelling, and application, to ensure that products are safe and effective before reaching the market and used properly by trained professionals. This includes evaluating the toxicity of active substances and formulations, setting maximum residue levels (MRLs) or tolerances, and mandating training for users.<sup>1</sup> While regulations vary significantly between countries, the common goal is to balance the benefits of crop protection with the protection of human health and the environment. Regulators worldwide control the use of agrochemicals through:

- 📍 **Registration and authorization:** agrochemical products must receive authorization from regulatory agencies before they can be sold or used, a process that evaluates the safety and efficacy of active substances and final product formulations.
- 📍 **Product-specific labelling:** product labels must contain legally binding instructions, including for storage, usage, and safety.
- 📍 **User training:** many regulatory frameworks mandate training for users of agrochemicals, to ensure they understand product safety, proper application techniques, and the rationale for using the product.
- 📍 **Maximum residue limits:** legal limits are set for residues of plant protection products in fruits and vegetables to protect consumers. In addition, regulatory frameworks include provisions for official controls and monitoring to ensure compliance with MRLs.

In nearly every country in the world, crop protection products must undergo a highly regulated, rigorous science-based risk assessment before they can be used, to ensure that they meet that country's human health and environment protection requirements.

These risk assessments often follow a systematic process, starting with data submission by manufacturers, followed by scientific evaluations and peer reviews by expert bodies before a final regulatory decision is made. Crop protection products that pass these assessments are granted a license or registration that permits their sale and use according to requirements set by regulators to protect human health and the environment. Setting an MRL or tolerance—the amount of chemical residue allowed to remain in or on each type of fruit or vegetable—is one component of this rigorous risk assessment process. The MRL or tolerance is the residue level that triggers enforcement actions. That is, if residues are found above that level, the non-compliant product is removed from the market, potentially destroyed, and may result in penalties for offenders. Tolerances apply to both fruits and vegetables grown on national soil and to imported produce. Some countries rely on the Codex Alimentarius Committee on Pesticide Residues to establish MRLs, while others set their own.

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<sup>1</sup> *Maximum residue limits (MRLs) refer to the maximum allowed concentration of pesticide or veterinary drug residues in food products, expressed in mg/kg.*

Agrochemical companies, or registrants, must submit a wide variety of scientific studies for review before regulators will authorize a plant protection product and set a tolerance. The data used in the risk assessment process are designed to identify:

- the toxicity of the agrochemical and its break-down products;
- how much of the chemical is applied, and how often and at what time before harvest the final application is permitted;
- how much of the chemical remains in or on food by the time it is marketed and prepared; and
- all possible routes of exposure to that chemical (residues on food products, as well as exposure from drinking water and residential exposure).

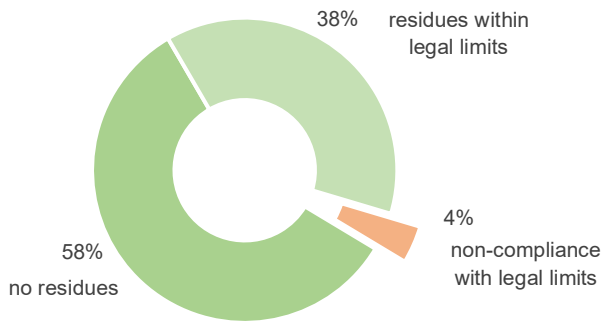
In setting tolerances, regulators must make a safety finding that the amount of an agrochemical that a person may eat based on their diet will not cause harm. To ensure that all tolerances established for each crop protection product are safe, regulators perform dietary risk assessments. These assessments combine survey information on food consumption with data on chemical residues to estimate exposure from food. The assessments account for the fact that infants and children consume more food for their size than adults; they also consider other vulnerable groups such as seniors and pregnant women. Information about dietary and other exposure is combined with information about toxicity to determine whether a tolerance is safe. First, the chemical's "no observable adverse effect level" (NOAEL) is determined—the maximum amount of residue that can be eaten before any adverse reaction is observed. Based on the NOAEL, regulators determine the "acute reference dose" (ARfD), the maximum amount that can be ingested in a single dose without adverse health effects. The ARfD is calculated by dividing the NOAEL by a factor of at least 100 to account for limitations and uncertainties in the data. Only when this safety margin has been established is the tolerance set, which is then much lower than the toxicological safety limits for every chemical and crop combination. **If health risks for the public are unacceptable, the tolerance will not be approved.**



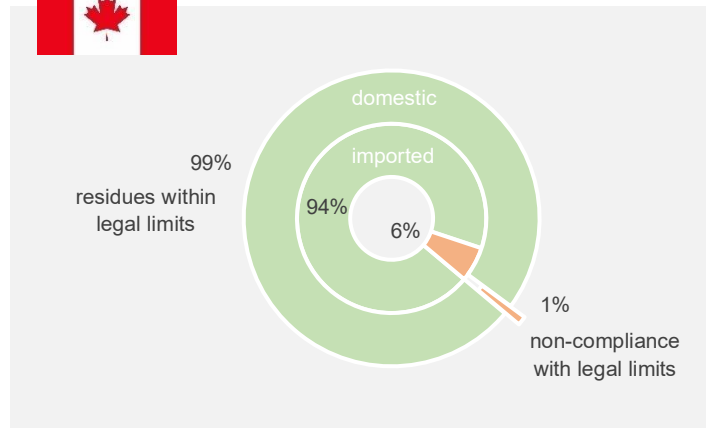
# EXCEEDANCES OF LEGAL TOLERANCES ARE RARE

The results of residue testing in the main consumption markets for fresh produce show that compliance rates are consistently very high, for both fruits and vegetables.

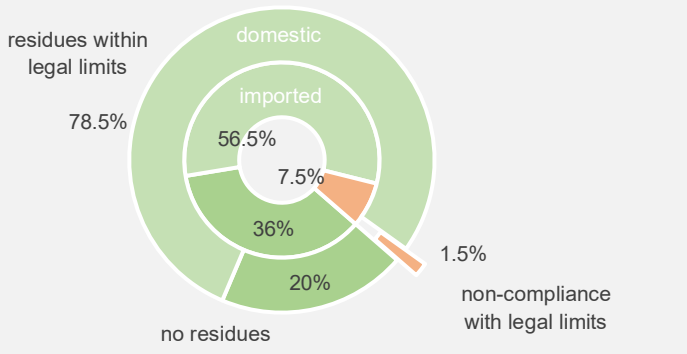
The following graphs show the latest residue testing results for the European Union,<sup>2</sup> the United States of America,<sup>3</sup> and Canada. In all three cases, overall compliance rates with legal tolerances are extremely high: 96 percent for domestic and imported produce in the European Union; 98.5 percent for domestic fruit, 94 percent for domestic vegetables, 92.5 percent for imported fruit, and 87 percent for imported vegetables in the United States of America; and 99 percent for domestic produce, and 94 percent for imported produce in Canada.



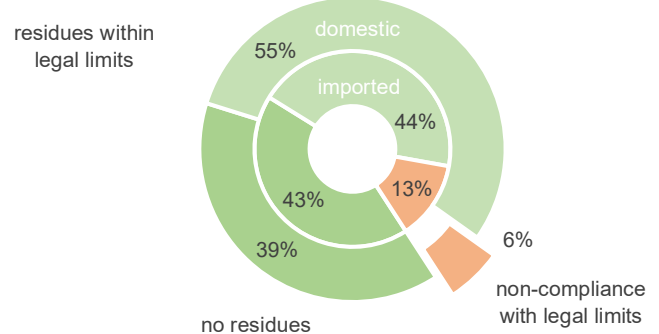
Source: EFSA, 2025.<sup>vi</sup>



Source: Health Canada, 2024.<sup>vii</sup>



Source: Food and Drug Administration, 2022.<sup>viii</sup>



<sup>2</sup> In the European Union, residue testing results are transmitted to the European Food Safety Authority (EFSA), which issues a comprehensive annual report on residues found in food products. According to EFSA's latest report, more than 132 000 targeted samples were collected and analyzed in 2023, for over 750 different pesticides. Four percent of all samples exceeded the MRL, of which 2 percent were found to be non-compliant after taking into account the measurement uncertainty. EFSA's annual reports can be found on the EFSA website at <https://www.efsa.europa.eu/en/news/pesticides-food-latest-data-published>.

<sup>3</sup> In the United States of America, the Food and Drug Administration analysed 2 800 samples of both domestic and imported foods under its regulatory monitoring program in 2022. Fruits and vegetables accounted for over three quarters of domestic samples.

As countries worldwide strive to improve food safety, the number and stringency of MRLs are on the rise. Today, MRLs for plant protection products have become one of the first element growers consider in their pest management decisions. Growers whose produce is exported to other countries must meet the often differing standards for each import market, creating a complex regulatory environment and increasing production and transaction costs. As residue regulations become more stringent, the lack of globally harmonized standards for chemical residues acts as a significant barrier to trade, especially for producers and exporters in developing countries.<sup>ix</sup>

The harmonization of MRLs would mitigate these trade disruptions, preventing import border rejections and safeguarding growers' livelihoods. Furthermore, the streamlining of registration processes and the recognition of agrochemical approvals across jurisdictions would facilitate faster access to innovative crop protection solutions, allowing growers to better combat pests and diseases. This would improve product quality and boost growers' competitiveness in both domestic and import markets. Ultimately, the harmonization of rules governing the use of agrochemicals and their residues across jurisdictions would create clarity and predictability, and reduce costs, along the entire supply chain.



**The global fresh produce industry urges policymakers to ensure that MRLs for fruits and vegetables are set based on risk- and science-based principles and international standards, and that regulatory frameworks facilitate the wider use of bio-based products to control the pests and diseases faced by growers worldwide. By streamlining and aligning regulations regarding the use of agrochemicals, national authorities can help achieve the right balance between guaranteeing food safety and ensuring that consumers have access to a wide range of healthy, nutritious, and affordable fruits and vegetables.**

# THE REAL RISK IS NOT PESTICIDE EXPOSURE BUT NOT EATING ENOUGH FRUITS AND VEGETABLES!

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Consumers can feel confident when buying and eating fruits and vegetables, no matter where they are grown. The thresholds set by regulators for chemical residues in fruits and vegetables incorporate 100- to 1000-fold safety margins, even for the most vulnerable consumer groups, and are rigorously enforced. The residues found in fruits and vegetables are consistently far below these safety limits. The real risk is not pesticide exposure but not eating enough fruits and vegetables!

Alarmist messages about pesticides in fruits and vegetables regularly pop up in the general media. While these reports command much media coverage, they are based on unscientific methodologies and usually focused on provoking fear. The main methodological flaw is that the reports do not incorporate a scientific risk assessment. Instead, they focus on the mere presence of pesticide residues in produce—overlooking how much of the product is actually on the food, how much of the food we are eating, and the toxicity of the ingested amount. In other words, these reports fail to consider that the mere presence of a residue on a fruit or vegetable does not mean that that fruit or vegetable is unsafe to eat. This reporting makes certain fruits and vegetables look “dangerous” even when residue levels are far below any level of health concern.

The presence of a detectable pesticide residue does not mean the residue is at an unsafe level. In other words, just because a fruit or vegetable contains a chemical residue does not mean that they are unsafe to eat.

First, modern analytical techniques can detect residues at extremely low concentrations—in the parts-per-billion (equivalent to a teaspoon of sugar in an Olympic-size swimming pool) or even parts-per-trillion range. These amounts are often thousands of times lower than levels that could cause harm. “Detectable” means *measurable*, not necessarily *dangerous*.

Second, MRLs are set using a risk-based approach, with large safety margins. This means that regulators do not just look at the intrinsic hazardous properties of a substance—they also assess how much of it people could realistically be exposed to through food, and whether that amount is safe. MRLs are calculated to ensure that even in a worst-case scenario—where someone eats large quantities of the food every day—total exposure would still be well below both the ADI for long-term safety, and the ARfD for short-term safety. The values set typically include large safety margins, often 100 to 1 000 times below the lowest dose shown to cause any effects in studies.

Based on the highest amount of residues ever detected in Canada, Health Canada estimates that you would have to eat about 280 apples every day, for your whole life, for there to be a health concern related to pesticide residues. Meanwhile, studies in the United States of America demonstrate that an adult woman would need to eat 453 servings of strawberries in one day before she might be at risk due to any chemical residue on the fruit.

The irresponsible interpretation and presentation of data is not the only issue at play. More seriously, these reports invoke unsubstantiated fears that undermine efforts by public health experts and government agencies to encourage consumers eat more fruits and vegetables. Worldwide, health agencies—including the Centres for Disease Control and Prevention and the US Department of Agriculture, the World Health Organization, the Food and Agriculture Organization of the United Nations, the European Commission's Directorate General for Health and Food Safety, the European Food Safety Authority, and many others—all emphasize that increasing fresh produce intake is vital for preventing multiple chronic diseases such as heart disease, diabetes, and cancer. Despite this consensus, food intake surveys worldwide demonstrate a chronic and persistent gap between actual consumption levels and intake recommendations for fresh produce that spans decades. **With consumers in both low- and high-income countries eating far too few fruits and vegetables already, one of the most troubling implications of these fear-inducing reports is their potential to dissuade people from eating fruits and vegetables that are perfectly safe.** Research has shown that consumers—and especially lower-income consumers—who are led to believe that conventionally grown fruits and vegetables are unsafe may avoid them altogether if organic options are not affordable or available.<sup>x</sup>

**People don't need any more barriers to eating fresh fruit and vegetables. The benefits of eating these excellent whole foods far, far outweigh any risk of chemical harm.**



The fresh produce industry is faced with the combined challenge of producing enough food for a growing world population in a more sustainable manner—while at the same time dealing with the impacts of climate change.

Recognizing the risks posed by the misuse or overuse of agrochemicals to the environment and human health, the industry is rapidly developing and implementing innovative solutions and technologies to reduce their use. This trend is further driven by an increasingly stringent regulatory approach to the use of agrochemicals and growing demand from consumers for sustainable and healthy food.

**All actors in the fresh produce industry, from growers all the way through to retailers, are firmly committed to providing consumers worldwide with a wide range of healthy and safe fruits and vegetables. At the same time, policymakers should streamline and align legislative frameworks governing the use of agrichemicals, ensuring that product approval and tolerance setting are based on science-based principles and harmonized international standards.**

The Global Coalition of Fresh Produce calls for continued action, collaboration, and knowledge sharing between the global fresh fruit and vegetable industry, policymakers, and other stakeholders to identify gaps in current efforts, develop strategies for improvement, and leverage our products' beneficial attributes for society and the environment. To join us on our journey, visit our website at [www.producecoalition.net](http://www.producecoalition.net) or contact us at [info@producecoalition.net](mailto:info@producecoalition.net).



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- <sup>i</sup> **Lamichhane, J.R.** 2017. Pesticide use and risk reduction in European farming systems with IPM: An introduction to the special issue. *Crop Protection*, 97:1–6. <http://dx.doi.org/10.1016/j.cropro.2017.01.017>
- <sup>ii</sup> **Gianessi, L. P. & Reigner, N.** 2005. *The Value of Fungicides in U.S. Crop Production*. Washington, DC, Crop Life Foundation. <http://croplifefoundation.files.wordpress.com/2012/07/completed-fungicide-report.pdf>
- <sup>iii</sup> **Nega, A.** 2025. Climate Change Impacts on Agriculture: A Review of Plant Diseases and Insect Pests in Ethiopia and East Africa, With Adaptation and Mitigation Strategies. *Advances in Agriculture*. <https://doi.org/10.1155/aia/5606701>
- <sup>iv</sup> **Delcour, I., Spanoghe, P., Uyttendaele, M.** 2015. Literature review: Impact of climate change on pesticide use. *Food Research International*, 68: 7-15. <https://doi.org/10.1016/j.foodres.2014.09.030>
- <sup>v</sup> **Elumalai, P., Gao, X., Parthipan, P., Luo, J. & Cui, J.** 2025. Agrochemical pollution: A serious threat to environmental health. *Current Opinion in Environmental Science & Health*, 43: 100597. <https://doi.org/10.1016/j.coesh.2025.100597>
- <sup>vi</sup> **European Food Safety Authority, Carrasco Cabrera, L., Di Piazza, G., Dujardin, B., Marchese, E. & Medina Pastor, P.** 2025. The 2023 European Union report on pesticide residues in food. *EFSA Journal*, 23(5): e9398. <https://doi.org/10.2903/j.efsa.2025.9398>
- <sup>vii</sup> **Government of Canada.** 2024. Collaborating for safer food and stronger agriculture. In: *Cultivating science*. Ottawa. [Cited 22 September 2025]. <https://science.gc.ca/site/science/en/blogs/cultivating-science/collaborating-safer-food-and-stronger-agriculture>
- <sup>viii</sup> **U.S. Food and Drug Administration.** 2022. *Pesticide Residue Monitoring Program Fiscal Year 2022 Pesticide Report*. Washington, DC. <https://www.fda.gov/media/181381/download>
- <sup>ix</sup> **Miao, W., Zenghui, H., Fuqiao, C. & Mei, Z.** 2025. The impact mechanism of MRLs standards harmonization on China's tea export trade—evidence from RCEP countries. *Frontiers in Sustainable Food Systems*, 9. <https://doi.org/10.3389/fsufs.2025.1504001>
- <sup>x</sup> **Huang, Y., Edirisinghe, I., Burton-Freeman, B.** 2016. Low-Income Shoppers and Fruit and Vegetables. What Do They Think? *Nutrition Today*, 51(5): 242–250. [https://journals.lww.com/nutritiontodayonline/fulltext/2016/09000/low\\_income\\_shoppers\\_and\\_fruit\\_and\\_vegetables\\_\\_what.6.aspx](https://journals.lww.com/nutritiontodayonline/fulltext/2016/09000/low_income_shoppers_and_fruit_and_vegetables__what.6.aspx)