TRADE4SD
Fostering the positive linkages between trade and sustainable development

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Deliverable 2.3: Database and infographics on standards rapprochement: STCs and bilateral measure of distance on pesticides and antibiotics

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Project Consortium

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Database and infographics on standards rapprochement: STCs and measure of distance on pesticides and antibiotics

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Acronyms

AMR	Antimicrobial Resistance
ASEAN	Association of Southeast Asian Nations
ASF	African Swine Fever
CA	Codex Alimentari
CAS	Chemical Abstracts Services
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EMA	European Medicines Agency
EU	European Union
F2F	Farm to Fork Strategy
FTA	Free Trade Agreement
IPPC	International Plant Protection Convention
LOD	Limit of Detection
MRLs	Maximum Residue Levels
NTMs	Non-tariff measures
OIE	Office International des Épizooties
PAN	Pesticide Action Network
PPPs	Plant Protection Products
SDGs	Sustainable Development Goals
SPS	Sanitary and Phytosanitary Standards
STCs	Specific Trade Concerns
TBT	Technical Barriers to Trade
WHO	World Health Organization
WOAH	World Organization for Animal Health
WTO	World Trade Organization

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Introduction

The impact of standards on bilateral trade flows, particularly in the agricultural sector, is a topic of discussion within the agricultural trade literature (Otsuki et al., 2001a,b; Achterbosch et al. 2009; Xiong and Beghin, 2014; Shingal et al., 2020; Drogué and DeMaria, 2012; Ferro et al., 2015; Fernandez et al., 2019; Curzi et al., 2020; Olper et al., 2014). With many countries shifting away from traditional barriers to trade (tariffs and other quantitative restrictions), towards non-tariff measures (NTMs) such as Sanitary and Phytosanitary Standards (SPS), the role of food safety standards has become crucial in shaping trade dynamics and market access. These standards, often seen as non-tariff barriers (NTBs) to trade (Swinnen, 2016), vary in their effects and can either facilitate or impede trade depending on their demand-enhancing effects.

The SPS Agreement allows World Trade Organization (WTO) members "to provide the level of health protection they deem appropriate" while ensuring that it does not result in unnecessary barriers to international trade. Members are encouraged to use international standards but may adopt higher levels of protection if based on sufficient scientific evidence (risk assessment). The international standards, guidelines, and recommendations referred to by SPS Agreement are developed by three other international organisations (the so-called "three sisters"):

1. the Codex Alimentarius Commission,

2. the World Organization for Animal Health (WOAH),

3. the International Plant Protection Convention (IPPC).

The aim of SPS and Technical Barriers to Trade (TBT) agreements is to protect consumers and the environment, prevent protectionism, and help industrial standardisation, giving technical boundaries for specific products. TBTs and SPSs often impact a product in one or several industries at once by improving trade, by way of better information and increasing confidence among partners or hurting trade by increasing the compliance cost for both exporters and domestic firms and the administrative burden, such as new environmental and production process requirements.

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The SPS Agreement regulates the legal framework of both sanitary (human and animal life or health) and phytosanitary (plant life and or health) measures.

In this work, we will focus on the regulation of pesticides and antibiotics, considering, on one hand, health-related aspects affecting both producers and consumers, and on the other, the implications for international trade in terms of trade barriers.

One of the objectives of the Horizon2020 project "TRADE4SD" is to offer policy recommendations for improving trade policies at the national, European, and global levels, including reforms to the WTO, and to enhance policy alignment. To achieve this goal, it is essential to address the impact of NTMs, which, despite their increasing use, remain largely underexplored in terms of the effects on international trade. This limited understanding is due to the complexity of NTMs and their effects are difficult to generalise. Several critical areas related to NTMs and their implications for international trade require further investigation, which "TRADE4SD" seeks to address. This work explores how NTMs affect market access for developing countries, as these nations may face various challenges, such as limited capabilities, technological gaps, weaker infrastructures and institutions, and asymmetric information. More specifically, "TRADE4SD" aims to identify best practices for improving the management of SPS, which are essential for enhancing the competitiveness of agricultural and food exports. Strengthening SPS capacity is also vital for boosting productivity in the agricultural and food processing industries, contributing to agricultural and rural development, and helping to alleviate poverty.

This deliverable consists of two main sections: one addressing Maximum Residue Levels (MRLs) for pesticides and antibiotics and the other focusing on Specific Trade Concerns (STCs).

In the first section, we analysed the regulations and then acquired and processed the data to create the databases, which we later used to develop the indices and infographics (for both pesticides and antibiotics).

In the STCs section, we analysed WTO documentation on all open disputes and verified their status. During our analysis, we identified the relationships between STCs and the Sustainable Development Goals (SDGs). Finally, we developed the infographics.

1. Linking Sanitary and Phytosanitary measures and Sustainable Development Goals

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Pesticides and antibiotics play a crucial role in food production, but their misuse poses significant challenges to economic, social, and environmental sustainability. Firstly, they can both lead to serious health issues. On one hand, the contamination of food and drinking water caused by some pesticide residues can harm consumers' health (European Commission, 2022). From a production perspective, farmers' exposure to large amounts of chemicals can result in illness and poisoning (Raimi et al., 2021). On the other hand, the misuse and overuse of antimicrobials in human, animals and plants are the main drivers of antimicrobial resistance (AMR). AMR occurs when bacteria, viruses, fungi, and parasites evolve to resist drugs, making infections more challenging to treat and increasing the risk of disease spread, severe illness, and death. The European Centre for Disease Prevention and Control (ECDC) estimates that 33,000 deaths occur annually in the European Union and the European Economic Area due to antimicrobial resistance associated with the excessive and improper use of antimicrobials in both human and animal healthcare (ECDC, 2022). Dependency on medication can be reduced by improving animal welfare, which includes enhancing both health and food quality.

Secondly, regarding the environment, excessive pesticide use can cause air, water, and soil pollution, which harms natural habitats, degrades the quality of ecosystem services, and contributes to biodiversity loss by harming non-target fauna and flora (European Commission, 2022). Concerning antibiotics, environmental issues stem from the contamination of aquatic systems with antibiotic residues and resistant bacteria derived from waste products from hospitals and agriculture (Baquero et al., 2008; Polianciuc et al., 2020; Khmaissa et al., 2024). Finally, the misuse of pesticides and antibiotics poses development threats that impact all regions. However, this impact is often more pronounced in low—and middle-income countries, where poverty and inequality significantly exacerbate the consequences. Therefore, regulating pesticides and antibiotics urgently requires political and institutional coherence and cooperation at the international level.

Regarding the relevant issues discussed in this section, the table below lists the SDGs most affected by SPS measures (Table 1).

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Table 1- Link between SPS measure and SDGs

	SDGs	Pesticides	Antibiotics
	SDG1 – No Poverty	✓	✓
	SDG2 – Zero Hunger	✓	✓
	SDG3 – Good Health and well-being	✓	✓
	SDG6 – Clean Water and Sanitation		✓
	SDG8 – Decent Work and Economic Growth		✓
	SDG12 – Responsible Consumption and Production	✓	✓
	SDG13 – Climate Action	✓	
	SDG15 – Life on Land	✓	
	SDG17 – Partnerships for the Goals	✓	✓

Source: Authors' elaboration

The European Green Deal and the Farm to Fork (F2F) Strategy are pivotal for achieving the SDGs. These initiatives outline ambitious targets to create a more sustainable and healthier food system. Effective implementation of these measures is expected to significantly enhance

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the competitiveness of EU producers and influence international food trade. To underscore the importance of the topic, three out of five of the main objectives of the F2F Strategy focus on SPS measures:

- The use and risk of chemical pesticides should be reduced by 50% by 2030; the use more hazardous pesticides should be reduced by 50% by 2030.
- Nutrient losses should be reduced by at least 50% and the use of fertilisers by at least 20% by 2030.
- Sales of antimicrobials for farmed animals and in aquaculture should also be reduced by 50% by 2030.

2. Differences in pesticides and antibiotics regulations

2.1 European Union's Regulation

a) Pesticides

MRLs of pesticides are defined by the European Commission as "the upper legal level of a concentration for a pesticide residue in or on food or feed based on good agricultural practice, and the lowest consumer exposure necessary to protect vulnerable consumers" (EU Regulation 396/2005). International agencies regulate MRLs to safeguard consumer health and ensure farmers adopt good practices.

According to the WTO rules, the regulation on MRLs of substances such as pesticides and insecticides should be based on (i) international standards such as those of the Codex Alimentarius (CA), (ii) science, including assessment of risk, (iii) a temporary principle of precaution in the absence of international standards or scientific evidence. While encouraging governments to orientate their import requirements towards internationally agreed standards, WTO rules recognise the right of individual countries to maintain its standards, providing that they are non-arbitrary, non-discriminatory, and less restrictive of trade. As countries persist as the primary regulatory authorities for food standards, domestic and import regulations variations persist across different nations.

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The establishment of MRLs for chemical pesticides indicates the increasing public awareness on the importance of environmental sustainability and human health in agricultural practices (Munir et al., 2024; Tudi et al., 2021). Although these standards are designed to safeguard human and animal health, they raise concerns due to their potential exploitation for protectionist purposes (Henson, 2021; Abdisa et al., 2023; Fernandes et al., 2021).

Food or feed for export to the EU cannot contain pesticide residues that exceed the MRLs decided by the Commission and the Council based on a risk assessment to consumer health by the European Food Safety Authority (EFSA). The EU regulatory framework for Plant Protection Products (PPPs) and their residues is comprised of the following two key regulations:

a) Regulation (EU) 1107/2009 (Pesticides Regulation) sets out the framework for placing active substances and PPPs on the EU market. Active substances can only be approved if they comply with both the hazard criteria and the risk assessment criteria.
b) Regulation 396/2005 (the MRL Regulation) controls pesticide residues and sets out the framework for setting MRLs in food and feed. The key aim of this Regulation was to support intra-community trade in the single market by establishing EU-harmonised MRLs. Unlike approval for an active substance, which requires environmental risks to be considered, MRLs are based solely on health grounds ('to protect vulnerable consumers') and do not consider environmental risks.

MRLs might not be set at the limit of detection (LOD) for substances not authorised in the EU because of the possibility of authorising import tolerances at the manufacturer's request.

The goal of the EU is to spread its standards to other countries, which depends on two factors: (a) how costly compliance is and (b) the significance of the EU as an export market for its products. Standards may vary because countries interpret the science differently, which can be influenced by the strength of vested interests affected by these standards in each nation. Furthermore, differences in exposure to specific risks or risk preferences can also lead to varying standards. In the F2F strategy, the Commission indicated its willingness to consider environmental risks when assessing requests for import tolerances for pesticide residues in imported food. This may require a revision of the MRL Regulation to strengthen its ecological dimension and make relevant alignments with the pesticide's approval process.

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b) Antibiotics

The EFSA coordinates the EU's AMR Surveillance Programmes in food-producing animals as directed by Directive 2003/99/EC and Commission Implementing Decision (EU) 2020/1729. Additionally, since 2019, the European Medicines Agency (EMA) has been analysing the sales and use of animal antimicrobial products following the guidelines of Regulation (EU) 2019/6. These regulations revise and substitute the previous Directive 2001/82/EC.

The European Commission adopted a new Animal Health Strategy in 2007, focusing on the principle that "prevention is better than cure". The strategy was based on four main pillars:

1) Prioritisation of EU intervention.
2) The EU Animal Health framework.
3) Prevention, surveillance, and preparedness.
4) Science, innovation, and research.

The most recent EU One Health Action Plan against Antimicrobial Resistance was adopted in 2017. It recognises the connection between human health, animal health, and the environment and emphasises the need for the EU to set a global best-practice example.

Regulation 2019/6 established rules for the sale, manufacture, import, export, supply, distribution, control, and use of veterinary medicinal products. The main goal is to endorse more informed use of veterinary medicinal products and improve animal and human health through the following regulations: a) Regulation (EU) 2019/4, which governs the manufacture, marketing, and use of medicated feed and imposes a complete ban on the use of antimicrobial veterinary drugs for prophylactic treatments; and b) Regulation (EU) 2019/5 which establishes procedures for the authorisation and supervision of medicinal products for human and veterinary use, founding the EMA.

The regulation specifies clear and harmonised labelling requirements, a more straightforward system for deciding exceptions, and a risk-based and control-based approach to pharmacovigilance. Approval is obviously required for clinical trials, taking care to protect animals used for scientific purposes. Marketing authorisation is required from a competent authority or the European Commission, as well as for involvement in any stage of the production of veterinary medicinal products or their import.

The regulation also sets clear rules for new biological therapies and veterinary medicines, and it continues and strengthens the EU's fight against antimicrobial resistance by introducing:

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- A ban on the preventive use of antibiotics in animal groups.
- A ban on the preventive use of antimicrobials through medicated feed.
- Restrictions on the use of antimicrobials as a control treatment to prevent further spread of infection.
- A strengthened ban on antimicrobials to promote growth and maximise yield.
- The possibility of reserving certain antimicrobials for human use only.
- Member States must collect data on the sale and use of antimicrobials.
- Scientifically based maximum limits for cross-contamination of feed with antimicrobials.
- Various measures for the careful and responsible use of antibiotics.

Furthermore, third countries will have to respect the prohibition on the use of antimicrobials for growth promotion and yield enhancement purposes and restrictions on antimicrobials designated for human use in the EU. This means that non-EU farmers producing for export to the EU are allowed to use antibiotics on an entirely regular basis, and in particular, their use for group prophylactic treatments will be allowed (Anderson et al., 2023; Nunan, 2022). Antibiotics can also be allowed to compensate for poor farming or poor hygiene. The lack of consistency between regulations could create trade disadvantages for EU farmers, enabling non-EU producers to continue abusing antibiotics to achieve cheaper production (Nunan, 2022). A critical article to consider in Regulation 2019/6 of 11 December 2018 is article 107, "Use of antimicrobial medicines", which states that if animals are managed in such a way as to become ill regularly, antimicrobials may not be used to compensate for poor hygiene, inadequate husbandry practices or lack of care, or for mismanagement of livestock.

The article states in paragraph 2, "Antimicrobial medicinal products shall not be used in animals to promote growth or increase productivity". In Paragraph 3: "Antimicrobial medicinal products shall not be used for prophylaxis except in exceptional cases, for administration to a single animal or a small number of animals where the risk of infection or infectious disease is very high, and the consequences may be severe. In such cases, the use of antibiotic medicinal products for prophylaxis shall be limited to administering to an individual animal only, under the conditions in the first subparagraph". Finally, in Paragraph 4: "Antimicrobial medicinal products shall be used for metaphylaxis only when the risk of spreading infection or infectious disease in the group of animals is high, and no suitable alternatives are available" (Regulation (EU) 2019/6; Schmerold, et al. 2023). Therefore, the regulation aligns with the EU action plan

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against antimicrobial resistance, which aims to reduce the use of veterinary medicines as set out in the F2F strategy.

The in-depth analysis of European regulation is preparatory to the development of the indices, described in the following sections, which measure the regulatory differences between the EU and its partners in terms of pesticides and antibiotics.

2.2 Objective of the study

Food safety, together with all issues related to the use of MRLs, has opened a lively debate in the literature, bringing attention both to the differences between regulations through comparison of limits, as well as on the impact of these on local industry and trade relations with the rest of the world. Differences between MRLs for the same substance and products between exporting/importing countries determine significant interferences on the intensity of the volumes internationally marketed.

Larger MRLs differences between exporting and importing countries increase export costs, hindering trade, especially for lower-income countries. The measurement of harmonisation or reciprocity of standards has been the subject of a stream of recent investigations on heterogeneity across countries for SPS and standard-like NTM regimes, using MLRs and other policies that can be aggregated meaningfully.

Concerning pesticides, several measures of distance between MRLs have been developed in the literature to evaluate their impact on international trade flows (*e.g.*, Otsuki et al., 2001a; Otsuki et al., 2001b; Xiong & Beghin, 2012; Vigani et al. 2011; Winchester et al., 2012; Drogué & DeMaria, 2012; Li & Beghin, 2014; Ferro et al. 2015; DeMaria & Drogué, 2017; Hejazi et al., 2022; Shingal & Erich, 2024). However, most of these indicators do not consider the toxicity level and the type of each pesticide. Hence, a considerable distance in MLR for a highly toxic substance has the same weight as a significant distance between a less harmful substance. Indeed, we believe that a more accurate measurement of the level of harmonisation in MLR regulation can shed light on the nature of non-tariff barriers and better inform the debate on the approximation of food safety standards.

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Unlike pesticides, academic literature has not yet investigated differences in antibiotic MRLs. To fill this gap, we develop an indicator based on Ferro et al. (2015) by applying it to antibiotic MRL regulations.

We aim to measure the degree of convergence or divergence of the EU MRL antibiotic regulations with its main partners. Calculating differences in rules allows us to verify the state-of-the-art and to do comparative analysis.

2.3 Methodology

a) Pesticides

i) Database

We built our MRLs database[1] starting from Agrobase-Logigram's Homologa[2] one, which provides data for 80 countries and 120,000 products (Table 2). The number of regulated substances is constantly increasing over time. The EU, Japan and Switzerland regulate the most significant number of pesticides, whereas Thailand, countries of the Gulf Cooperation Council and ASEAN countries a much lower number (78, 30 and 76, respectively). South Korea, Turkey and Norway have increased the number of regulated substances between 2008 and 2020. The reason why USA, Australia and Argentina show a lower number of regulated substances depend on the fact that the database does not show MLR when MLR are equal to 0. Indeed, countries follow different rules when not specifying an MLR for a given substance (Table 3), as residues can be: a) equal to 'zero'; b) below a specified default limit (generally 0.01 mg/kg); c) below the concentration of dietary intake concern; d) equal to the MLR of the importing country when exporting to that country.

[1] https://zenodo.org/records/13847021

[2] We use data from Agrobase-Logigram, data are obtained directly from each country's pertinent ministry, data are available at teh following link The Global Crop Protection database | Homologa

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Table 2: Number of pesticides registered between 2008 and 2020

Country	2008	2016	2020
Argentina	263	324	327
ASEAN	60	78	76
Australia	366	388	462
Brazil	303	331	295
Canada	201	304	348
Chile	163	167	163
China	137	389	511
CODEX	163	224	283
Colombia	163	175	146
Costa-Rica	-	-	249
Egypt	163	175	
EU	541	1102	1297
Gulf Council Cooperation	-	17	30
Hong Kong	-	359	361
India	166	153	265
Indonesia	-	193	193
Israel	284	265	326
Japan	613	704	785
Korea South	391	493	547
Malaysia	170	176	187
Mexico	219	224	294
Morocco	-	-	270
New Zealand	199	315	405
Norway	267	1104	1160
Peru	-	-	186
Philippines	-	-	113
Russian Federation	314	463	471
Saudi Arabia	-	-	520
Singapore	-	107	116
South Africa	328	342	453
Switzerland	429	497	531
Taiwan	354	391	410

Source: Agrobase-Logigram's Homologa database

Starting from the Homologa database, we created a unique ID (ranging from 1 to 1146) for each pesticide and then classified the pesticides by type (fungicides, herbicides, etc.). We then compared the classification of the database of active substances approved under Regulation (EC) No1107/2009 with the Homologa one. The approved substances database includes the ID of each active substance. According to the data, 452 substances were approved, 937 were not approved, 64 were pending approval, and 0 were banned, totalling 1472 substances. Subsequently, this information was further matched with the Pesticide Action Network (PAN) International list, which classifies substances according to their Chemical Abstracts Service (CAS) number, a code associated with the pesticide that indicates its toxicity class. Here, we distinguished four different toxicity categories as specified in Table 3.

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Table 3 - Desciption of toxicity calssification and typology of pesticides

Toxicity Class	Definition	Typology
Ndia	Highly toxic	Fungicides/Insecticides/Herbicides
Ndib	Toxic	Fungicides/Insecticides/Herbicides
Moderate	Moderately toxic	Fungicides/Insecticides/Herbicides
N slightly	Slightly toxic	Fungicides/Insecticides/Herbicides

Source: Author's analysis and computation based on WHO and Homologa data

This merging process was performed individually for all the countries listed in Table 2, assessing whether all pesticides were regulated simultaneously by both countries. Finally, all this information was combined in a single dataset. To double check the information on toxicity levels, substances in our database were also matched with the World Health Organization (WHO) list, which provides tables with the CAS numbers.
This information resulted in a comprehensive database combining the list of substances regulated by different countries based on the class of pesticides and their toxicity levels.

ii) Index

Intending to fill the gap in existing literature, we propose the following adjusted index (AI) between the two countries i and j (i ≠ j) for product k and class of pesticides h:

$$AI_{EU-World(crop,pesticides)} = \frac{1}{N_{k,s,h}} \sum_{i=1}^{n} \frac{MRL_{i,\,k,s} - MRL_{j,k,s}}{Max(MRL_k) - Min(MRL_k)} \quad (1)$$

where N_{ksh} denotes the number of chemicals *s* in chemical class *h* used to produce commodity *k*. MRL_{iks} is the MRL set in the exporting country *i* for pesticides *s* and product *k*. MRL_{jks} is the MRL set in the importing country *j* for pesticide *s* and product *k*. Max(MRL_k) is the greatest MRL for product *k*, and Min(MRL_k) is the lowest MRL for the same pair of products/substances. In doing so, our measure varies by product/country pairs and type of chemical class. This indicator will be adapted to measure differences in MRLs for antibiotics in the following section.

To take into consideration the level of toxicity, we calculate again the distance (WI) weighting it for the toxicity level of substances, as described in the following formula:

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$$WI_{EU-World(crop,pesticides)} = \frac{1}{N_{k,s,h}}\left(\sum_{i=1}^{n}\frac{MRL_{i,\,k,s}-MRL_{j,k,s}}{Max(MRL_k)-Min(MRL_k)}\right) * w_{tox} \quad (2)$$

where w_{tox} is the weight associated with the different toxicity classes (the higher the toxicity level the higher the weight).

Both indices vary between -1 and 1, assuming a negative (positive) value when the EU partner—the exporter country in the formulas—has a stricter (lax) regulation than the EU. The indices are equal to 0 if the EU and its partner share the same regulation.

We use these indices to develop our infographics. First, we applied the second equation (2) to create a map that provides an overview of countries' regulations on pesticides' MRLs, considering the toxicity level of substances.

Next, Equation (1) was used to synthesize each country's MRL regulation based on each toxicity level. We created two maps, one for slightly toxic substances and one for highly toxic substances, to investigate and compare differences in regulations. Subsequently, we followed the same approach to focus on specific crops.

iii) Infographics

We utilised our synthetic index to develop infographics[3] that highlight regulatory differences in between the EU and partner countries. The data derived from this indicator was translated into a colour-coded map, with the colours representing the degree of regulatory divergence between partner countries and the EU, which serves as the benchmark reference. These infographics are designed to make the study's findings more accessible, providing a clear and immediate visual representation of information on SPS regulations.

The infographics are produced at a general level for each country, summarising their overall regulatory approach. We then developed more detailed maps for specific products relevant to the project, particularly within Work Package 2 (cocoa, olive oil, coffee, cashews, and apples). The infographics were designed to reflect two distinct levels of toxicity, highlighting how MRLs are regulated differently depending on toxicity levels, even within the same country. The country-level maps indicate that nations with more stringent regulations typically enforce strict policies uniformly, and not based on toxicity. In contrast, countries with less stringent

[3] https://zenodo.org/records/13847021

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regulations tend to vary their approach depending on the toxicity of the substances. Countries with an index value that is equal to zero or close to zero, which have regulations fairly aligned with those of the European Union, generally maintain the same position when transitioning from the simple index (Figure 1) to the weighted index (Figure 2). When variations do occur, they tend to be marginal. In contrast, as previously mentioned, countries with regulations that significantly differ from those of the European Union behave differently depending on toxicity classes. This divergence is evident in both the simple and the weighted indices. These findings suggest that if toxicity classes are not considered, there is a risk of misinterpreting the regulatory framework[4]. Indeed, in general when toxicity is considered in the analysis, the distance between the regulations decreases (Figures 3 and 4).

Overall, nations that are aligned or even have slightly stricter regulations compared to the EU are countries in North America, Argentina, Australia, New Zealand, South Africa, China, and Japan. It is important to emphasize that all these countries have close trade relations with the Union. Together with Ukraine, the countries of the Gulf Cooperation Council, Southeast Asia, and, except for Argentina, those in Latin America are the ones that, to varying degrees, diverge the most from EU regulations.

A comprehensive analysis of pesticide regulations at the global level is not possible due to a lack of data, with some exceptions, for entire geographic regions such as Central America, Central and South Asia, and almost all of Africa.

[4] Depending on the weight assigned to toxicity, variations in the flattening of distances can be observed. The key message is that, while it is appropriate to consider toxicity, it is equally important to reflect on the significance of the weight attributed to it, as this factor is crucial in determining the distances within countries' regulations.

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Infographics by country

Figure 1- Differences in pesticide regulation between the EU and its partners (Simple Mean)

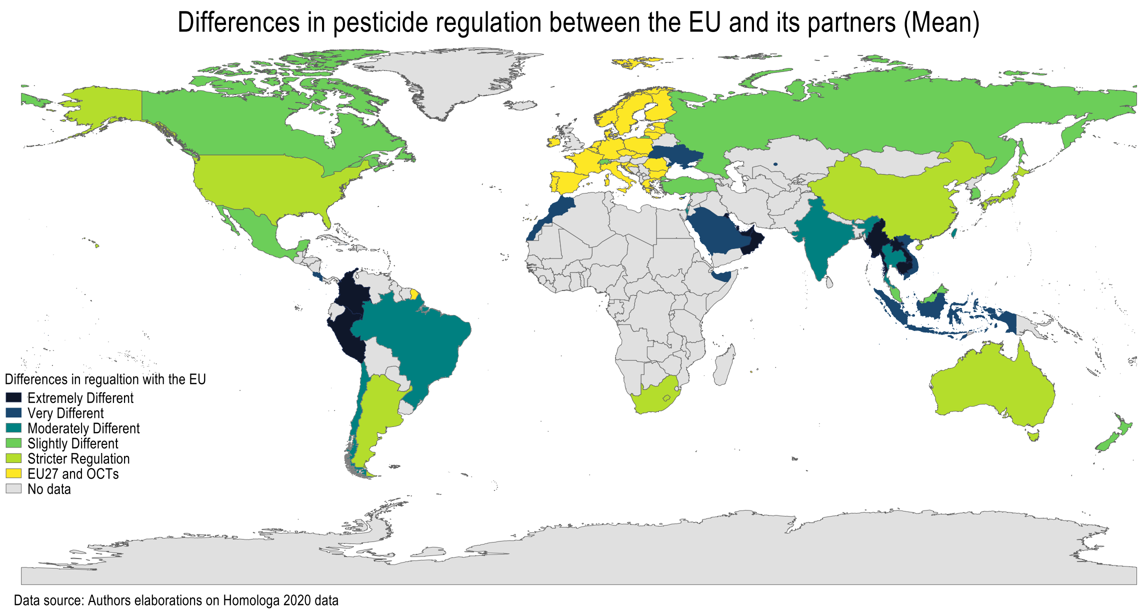

Figure 2 - Differences in pesticide regulation between the EU and its partners (Weighted Index)

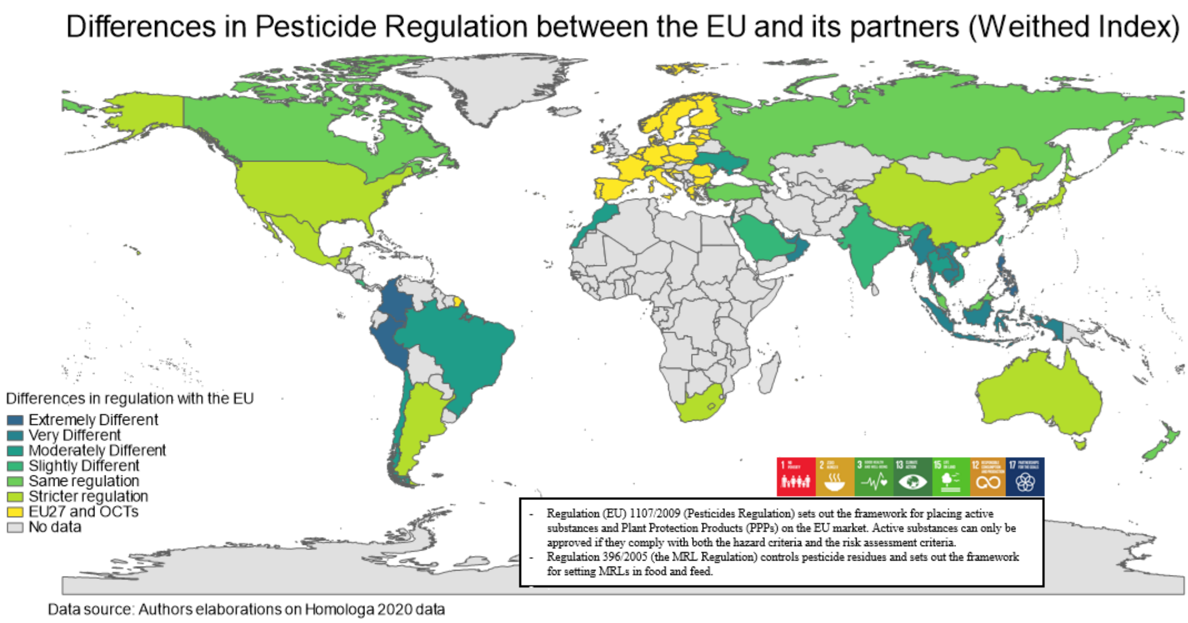

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Figure 3 - Differences in MRLs regulation between the EU and its partners for highly toxic pesticides

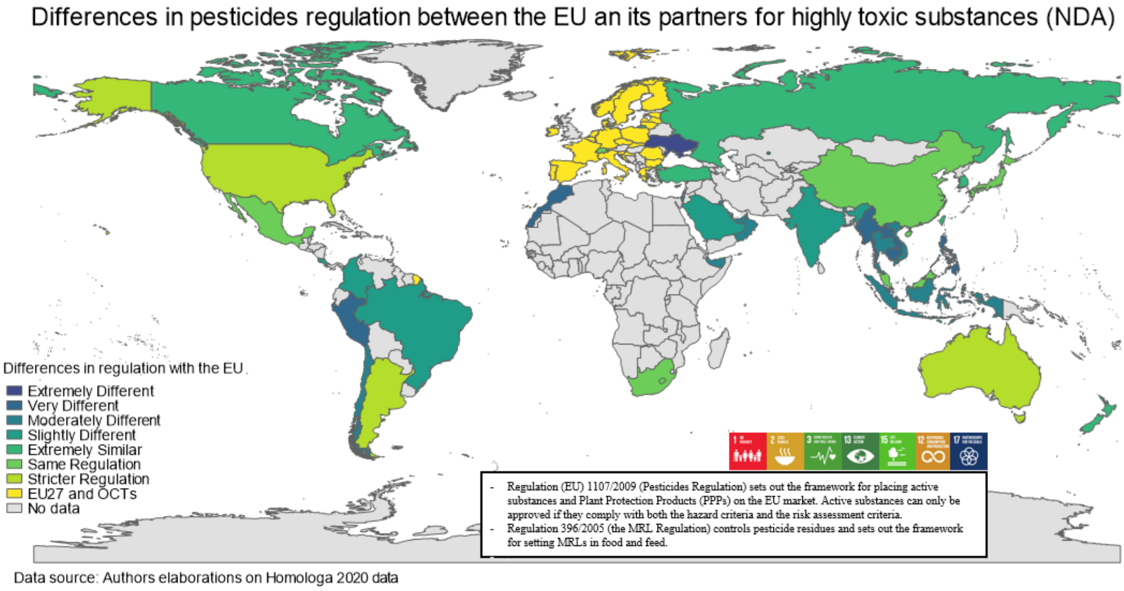
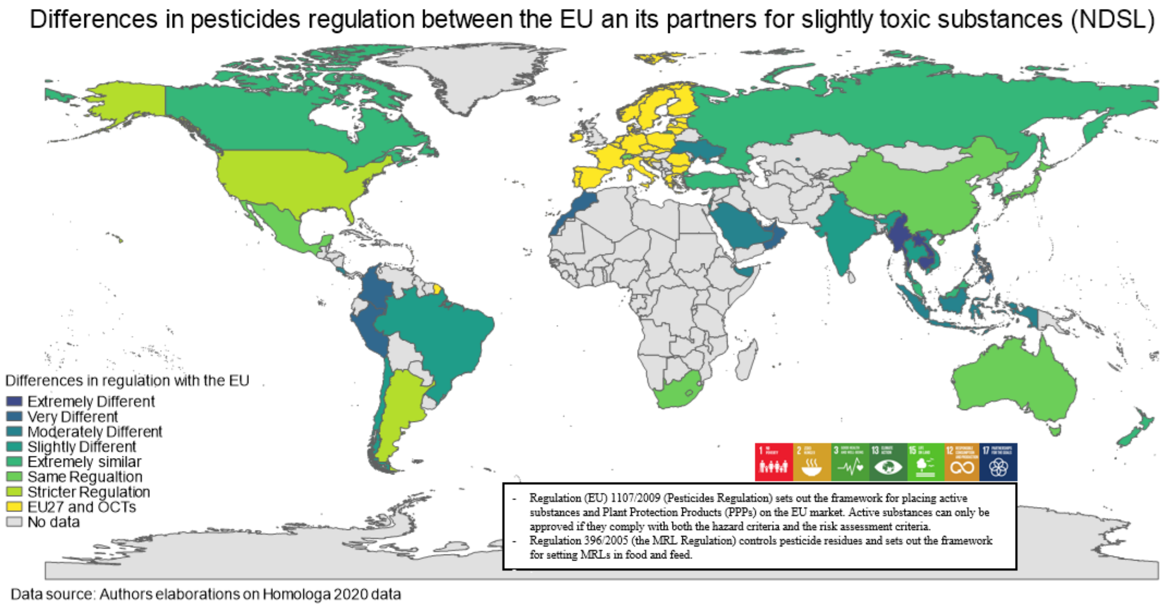


Figure 4 – Differences in MRLs regulation the EU and its partners for slightly toxic pesticides



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Infographics by crop

Regarding apples (Figures 5 and 6), there is essentially no difference in the regulation of substances based on toxicity. The only exception is South America, where Brazilian and Chilean regulations diverge more from the Union's regulations for highly toxic substances, while the opposite is true for Peru and Colombia.

Figure 5 - Differences in MRLs regulation the EU and its partners for apples (highly toxic pesticides)

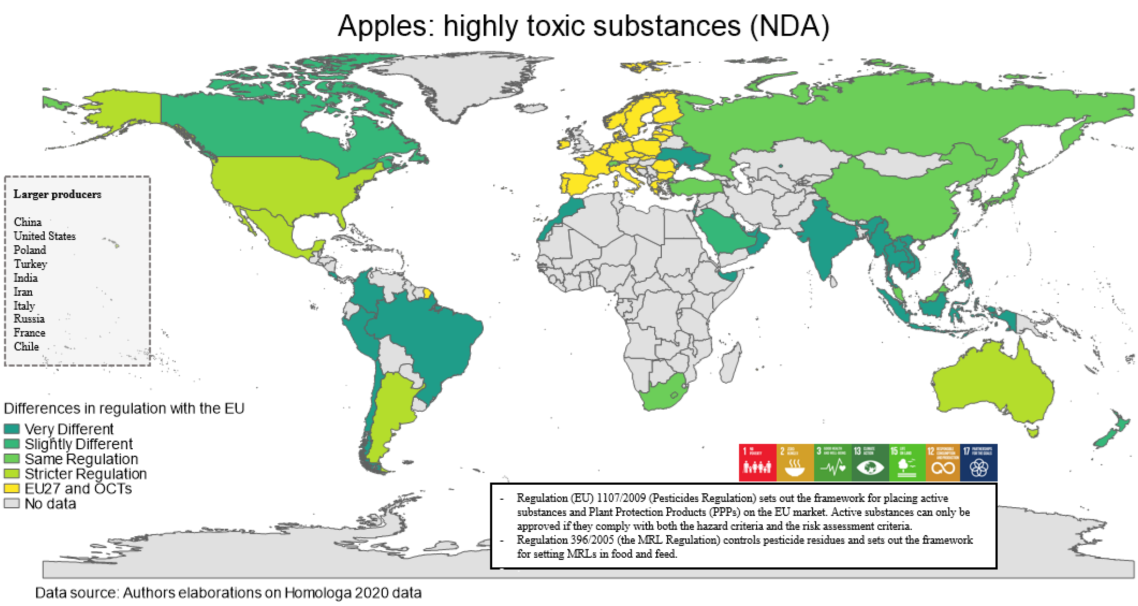

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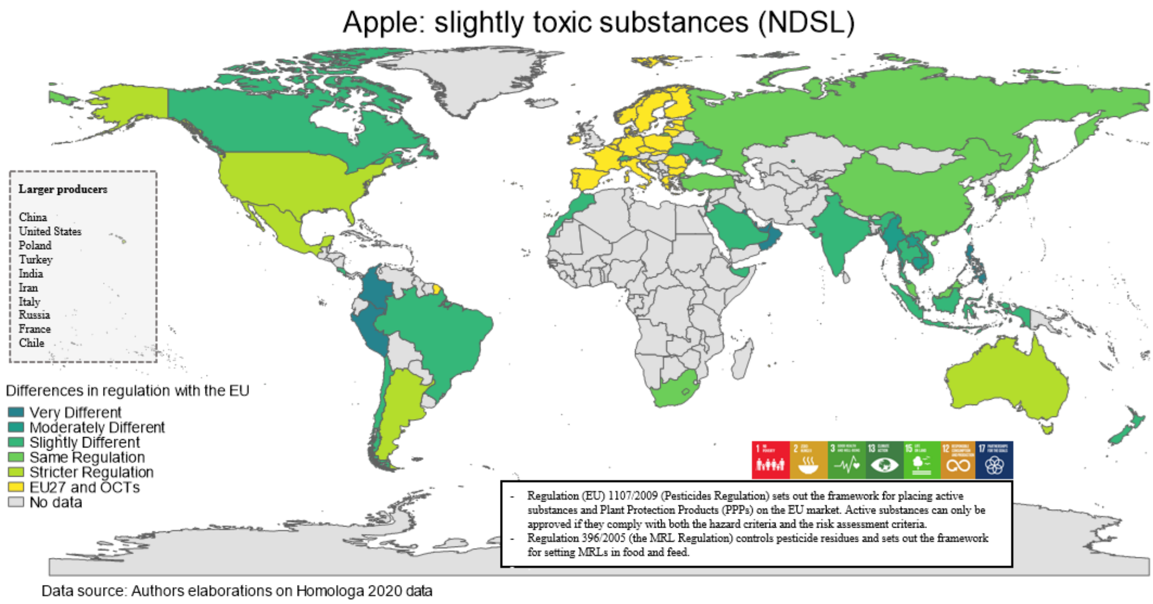
Figure 6 - Differences in MRLs regulation the EU and its partners for apples (slightly toxic pesticides)



Cocoa presents a unique case compared to the trends observed in the country-level maps (Figures 7 and 8). With the exception of North America, Argentina, Australia, New Zealand, South Africa, China, Russia and Japan, heterogeneity in regulations increases for highly toxic substances while decreasing for slightly toxic ones.

Figure 7 - Differences in MRLs regulation the EU and its partners for cocoa (highly toxic pesticides)

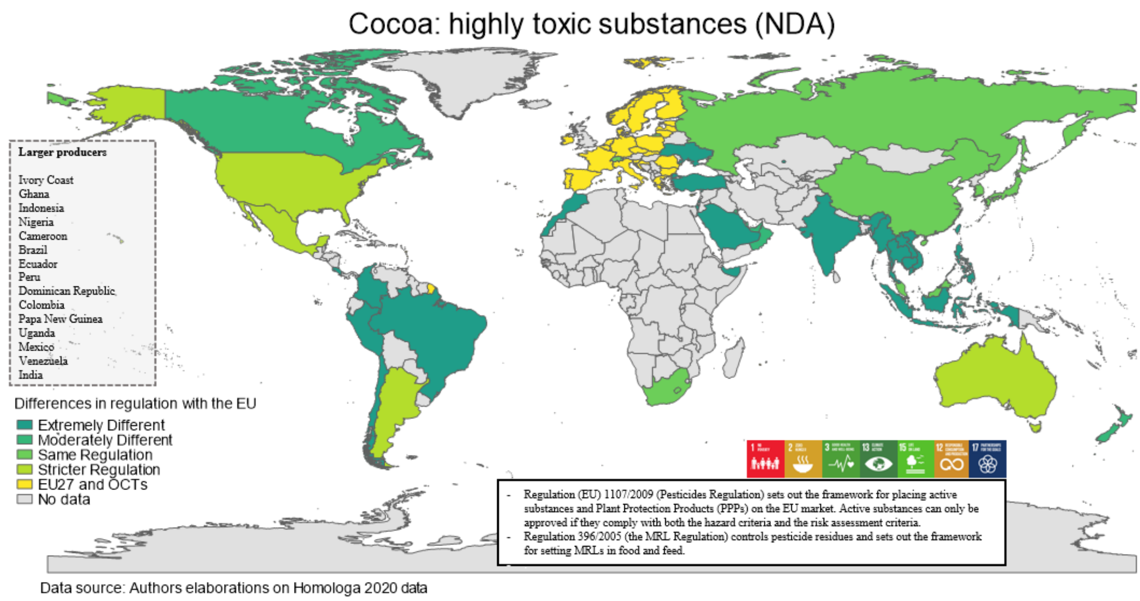


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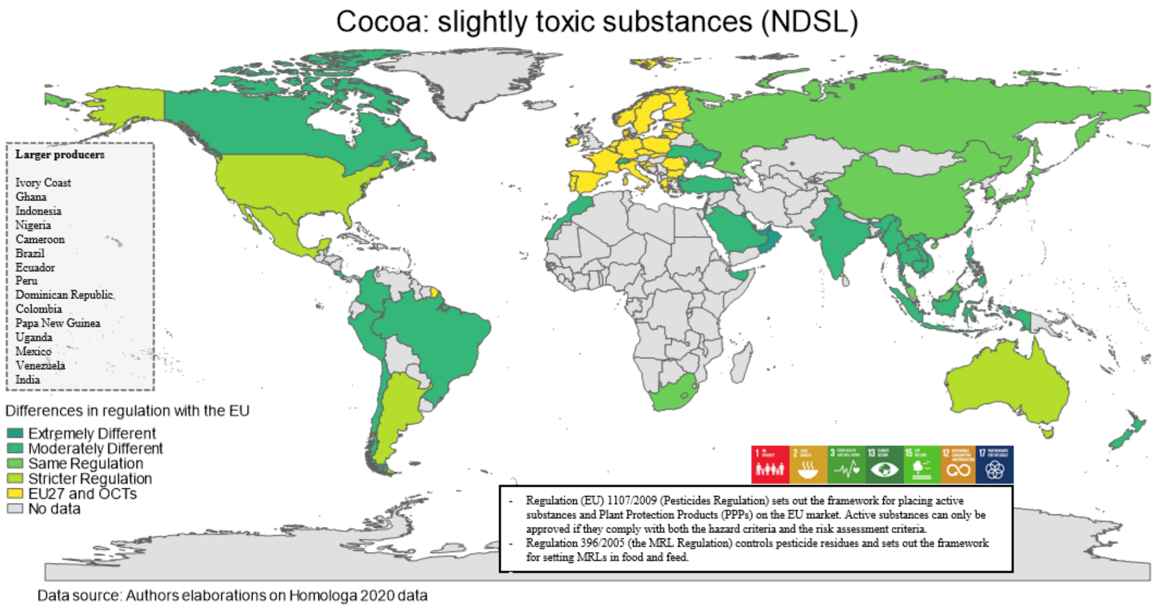
Figure 8 - Differences in MRLs regulation the EU and its partners for cocoa (slightly toxic pesticides)



Overall, countries' regulations for cashew reflect those shown in the broader maps.

It is interesting to highlight that, in the case of this crop, there are no differences in pesticides regulations based on toxicity levels (Figures 9 and 10).

Figure 9 - Differences in MRLs regulation the EU and its partners for cashew (highly toxic pesticides)

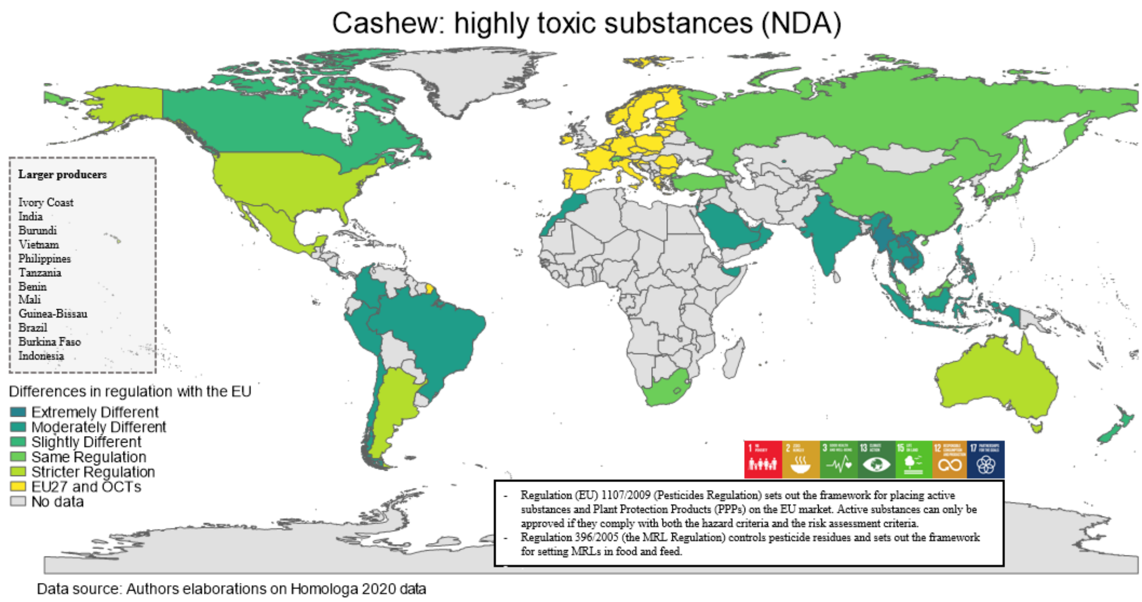


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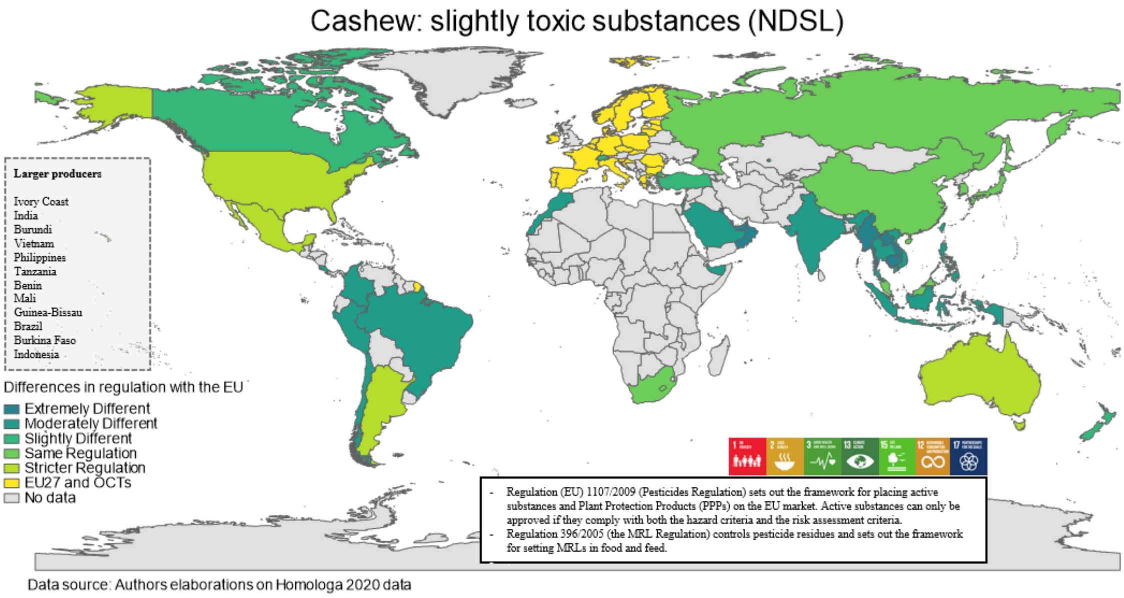
Figure 10 - Differences in MRLs regulation the EU and its partners for cashew (slightly toxic pesticides)



When analysis coffee, countries are less aligned with the EU regulations concerning substances with lower levels of toxicity (Figures 11 and 12). In this case as well, nations that have regulations aligned with those of the EU (North America, Argentina, Australia, New Zealand, South Africa, China, Japan, Russia) do not show heterogeneity conditioned to toxicity.

Figure 11 - Differences in MRLs regulation the EU and its partners for coffee (highly toxic pesticides)

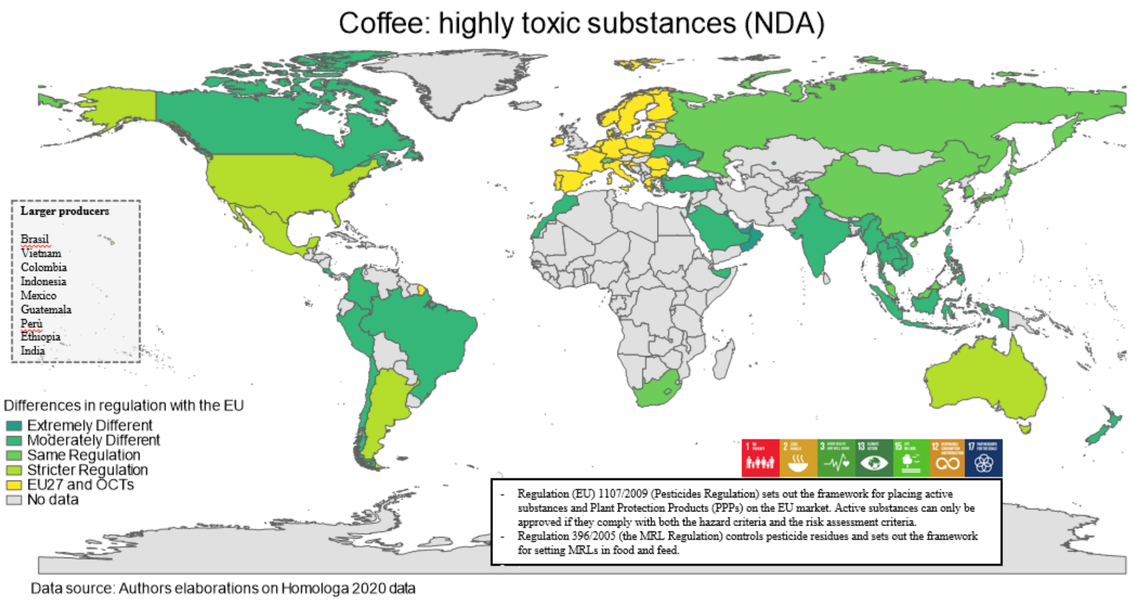


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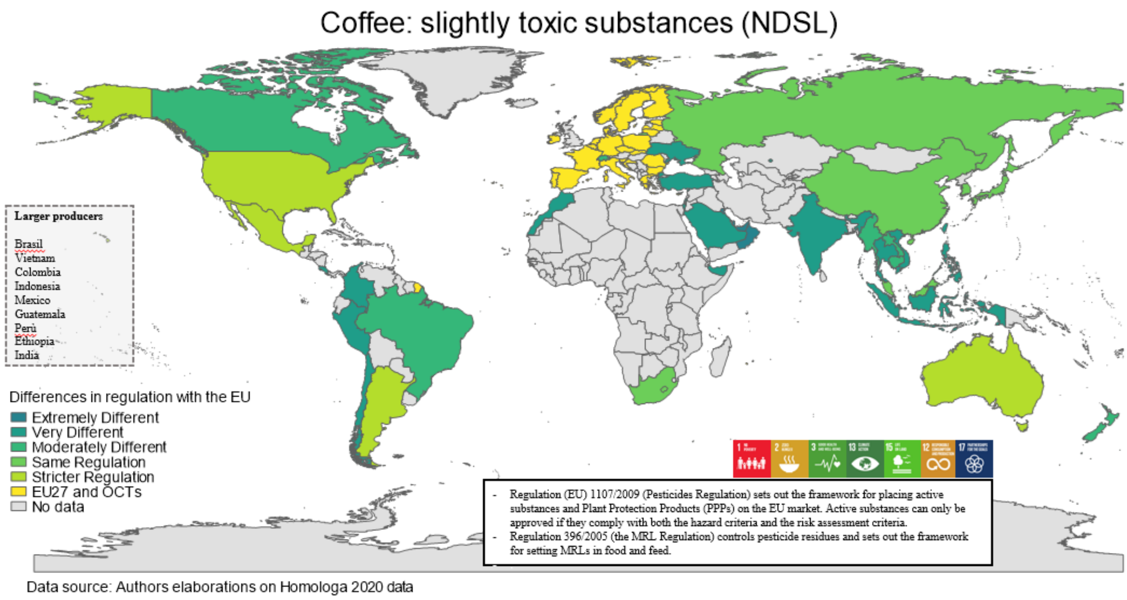
Figure 12 - Differences in MRLs regulation the EU and its partners for coffee (slightly toxic pesticides)



The maps on olive oil (Figures 13 and 14) are related to the case study of Tunisian olive oil from Task 2.2. There are no substantial differences in regulations related to toxicity levels as the primary producers and exporters are the countries of the Union.

Figure 13 - Differences in MRLs regulation the EU and its partners for olive oil (highly toxic pesticides)

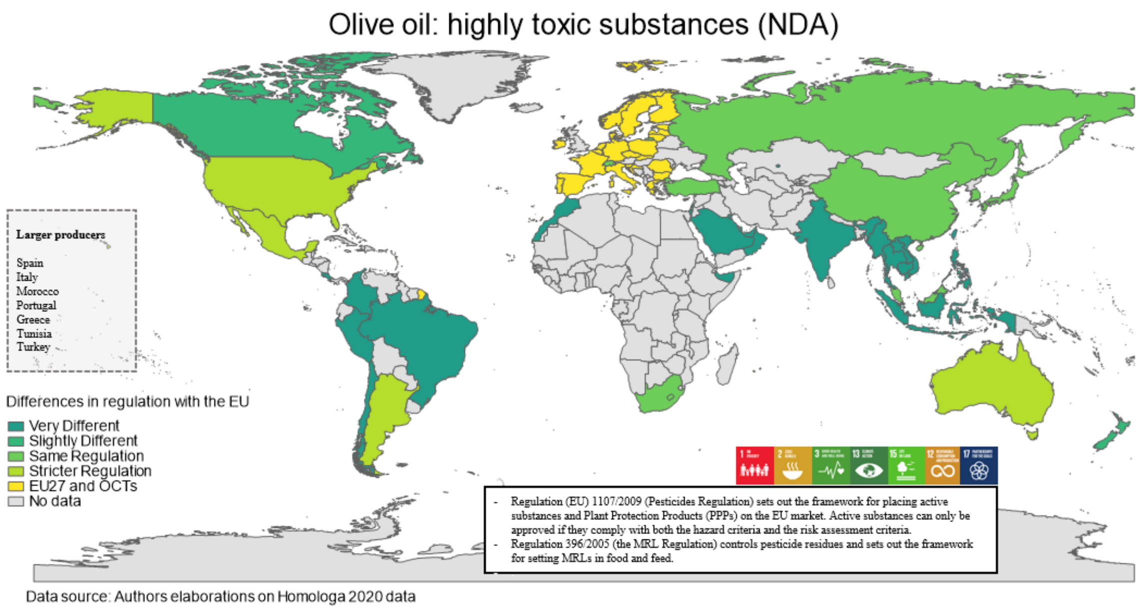


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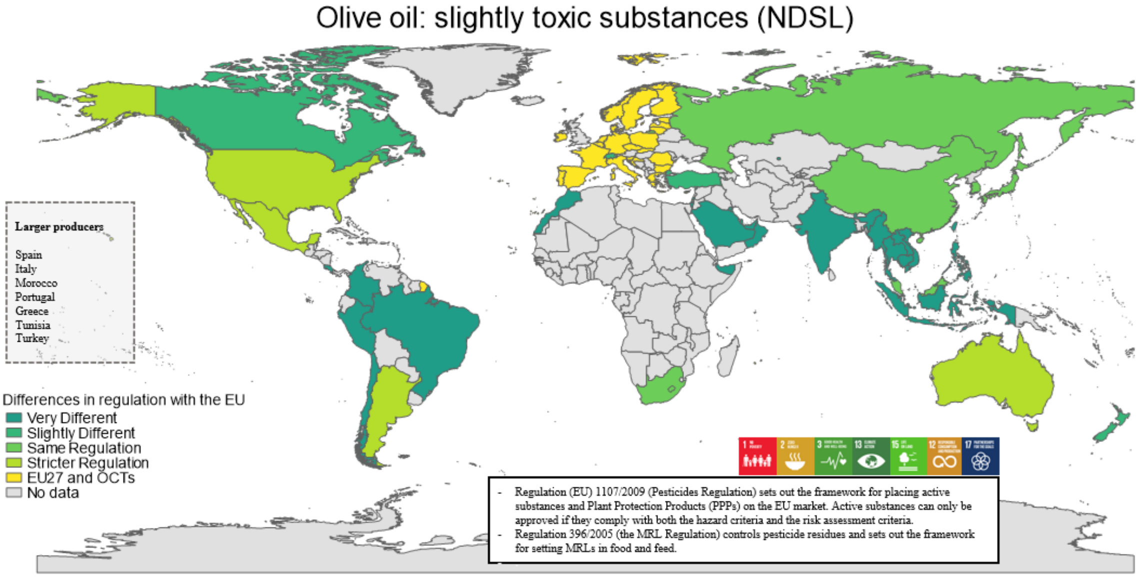
Figure 14 - Differences in MRLs regulation the EU and its partners for olive oil (slightly toxic pesticides)



Data source: Authors elaborations on Homologa 2020 data

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b) Antibiotics

i) Database

The data used to construct the distance index for antibiotics are from the BC Global Veterinary Drugs database[5]. This database of global MRLs on animal products provides all the necessary information for studying and comparing standards across countries. BCglobal is a regulatory platform from which we can derive the MRLs for pesticides, veterinary drugs, contaminant limits, and food additive regulations. The database's main features can be summarised as follows:

1) Exploration/examination/comparison of MRLs for over 400 veterinary drugs on all animal regulatory products in all major export markets.
2) Initial regulatory reference and subsequent amendments where applicable.
3) Access to reports providing comprehensive regulatory frameworks for each country.

We extracted the MRLs of veterinary drugs used in 62 countries for 11 products: buffalo, beef, chicken, duck, goat, horse, pigeon, rabbit, sheep, pig, and turkey. Once again, regulating antibiotic MRL varies from country to country. Some countries, such as the EU and the USA, have strict rules, while others follow the list of substances established by CODEX. In contrast, some countries refer to the destination country's regulations when there are no standard rules in place. Table 4 shows the legislative references for the countries being analysed. More specifically, the table illustrates the regulatory framework for managing antibiotics, including substances not covered by the legislation of the respective country. The first column lists the country, while the second column specifies the country or international organization to refer in the absence of domestic regulation (e.g., if Afghanistan does not regulate a certain substance, the value established by Codex is referenced).

[5] We utilised the global MRL database maintained by the Foreign Agricultural Service available at the following linkhttps://fas.usda.gov/maximum-residue-limits-mrl-database.

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Table 4 – Countries legislative reference

Country	Legislative Reference	Country	Legislative Reference	Country	Legislative Reference
Afghanistan	Codex	Finland	EU	Netherlands	EU
America Samoa	USA	France	EU	Nicaragua	Nicaragua
Argentina	Argentina	Germany	EU	Northern Ireland	EU
Armenia	Russia	Greece	EU	New Zealand	Nuova Zealand
Australia	Australia	Japan	Japan	Northern Mariana Island	USA
Austria	EU	Great Britain	Great Britain	Oman	GCC
Belarus	Russia	Guam	USA	Panama	Codex
Belgium	EU	Guatemala	Guatemala	Peru	Peru
Belize	Codex	Gulf Cooperation Council	Gulf Cooperation Council	Philippines	Codex
Bahrain	GCC	Honduras	Honduras	Poland	EU
Brazil	Brazil	Hong Kong	Hong Kong	Portugal	EU
Bulgaria	EU	Hungary	EU	Puerto Rico	USA
Cameroon	Codex	India	India	Qatar	GCC
Canada	Canada	Indonesia	Indonesia	Romania	EU
Chile	Chile	Ireland	EU	Russia	Russia
China	China	Italy	EU	Saudi Arabia	GCC
Codex	Codex	Kazakhstan	Russia	Singapore	Singapore
Colombia	Colombia	Kenya	Codex	Slovakia	EU
Costa Rica	Costa Rica	Korea	Korea	Slovenia	EU
Croatia	EU	Kuwait	GCC	Spain	EU
Cyprus	EU	Kyrgyzstan	Russia	Sweden	EU
Czech Republic	EU	Latvia	EU	South Africa	South Africa
Denmark	EU	Lithuania	EU	Taiwan	Taiwan
Dominican Republic	Dominican Republic	Luxembourg	EU	Thailand	Thailand
Egypt	Egypt	Macau	Macau	Tonga	Codex
El Salvador	El Salvador	Malaysia	Malaysia	Turkey	Turkey
EU	EU	Malta	EU	US Virgin island	USA
Estonia	EU	Mexico	Mexico	United Arab Emirates	GCC
Fiji	Codex	Myanmar	Codex	United States	USA
				Vietnam	Vietnam

Source: Authors' elaboration based on BCGLOBAL 2020

In the database, we identified various categories of drugs, including hormones, pesticides, anti-inflammatory medications, anticoagulants, antiseptics, antifungals, and antibiotics. We focused

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explicitly on antibiotics to calculate the distance and assess the similarity between regulations. We extracted data from the database files to create tables illustrating the connections between the studied countries, their legal references, the minimum and maximum residue limits for each substance related to a particular product, and the total number of these substances regulated in each country. Table 5 presents the total count of drugs each country regulates, specifically on veterinary medicines.

Table 5 - Total count of drugs regulated by each country

Country	Tot N	Country	Tot N	Country	Tot N
America Samoa	81	Guam	103	Peru	210
Argentina	81	Guatemala	210	Philippines	81
Armenia	131	Gulf Cooperation Council	65	Russia	131
Australia	120	Honduras	210	Saudi Arabia	65
Belarus	131	Hong Kong	69	Singapore	149
Belize	81	Japan	365	South Africa	409
Bahrein	65	India	210	Taiwan	143
Brazil	215	Indonesia	126	Thailand	50
Cameroon	81	Kazakhstan	131	Tonga	81
Canada	94	Kenya	81	Turkey	186
Chile	133	Korea	210	US Virgin Island	103
China	163	Kuwait	65	United Emirates	65
Codex	81	Kyrgyzstan	131	United States	81
Colombia	65	Macau	17	Vietnam	64
Costa Rica	210	Malaysia	95		
Dominican Republic	210	Mexico	95		
Egypt	67	Mexico	95		
El Salvador	210	Nicaragua	131		
EU	203	New Zealand	409		
Fiji	81	Panama	81		

Sources: BCGlobal database

The table clearly indicates that the number of regulated substances varies by country. New Zealand and South Africa are the top countries with the most regulated substances. Japan has 365 regulated substances, with all EU countries following suit. These differences also apply to

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controlled substances for all product subcategories, with the EU regulating an average of 548 substances, the USA 87, Codex 153, Brazil 470, New Zealand 665, Australia 197, China 357, Japan 381, and South Africa 409. Additionally, there are various limits for Maximum Residue Levels (MRLs) measured in parts per billion (ppb). Among the substances listed in Table 6 with a threshold value, only Carbomycin, Penicillin, Sodium Sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine, Sulfachlorpyridazin, Metronidazole, and Dapsone are antibiotics. We analysed the potential toxicity of antibiotics. After consulting with a professional, we were advised not to consider this hypothesis. Unlike pesticides, antibiotics are regulated for human use, making it difficult for residues to pose a high risk to our bodies. The toxicity of antibiotics to humans is determined based on the dosage. Exceeding the recommended dosage can pose real risks to human health. The possibility of certain dangers through food contamination is not impossible but very rare since we are talking about antibiotic residues; therefore, minimal amounts can reach humans through food and would not go beyond the dose of regulated "toxicity". On the contrary, as the literature shows, there is a greater possibility of being able to meet the phenomena of antibiotic resistance through food (Wu-Wu et al., 2023; Okaiyeto et al., 2024). These findings are crucial for understanding the potential impact of regulated substances on human health and food safety.

Our research is based on a comprehensive database[6] of 35 exporting countries, resulting from grouping countries with the same regulatory references, one importing country (the EU), and 11 meat products. The infographics specifically refer to beef, pork, chicken, and turkey meat. The list of drugs includes 409 substances, including insecticides, antibacterial agents, growth promoters, and antimicrobial agents, focusing on 122 antibiotics.

[6] https://zenodo.org/records/13847021

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Table 6 – Summarising table with default values on veterinary drugs

Country	Products	Veterinary Drug	Threshold value
America Samoa	Cattle, chicken, sheep, pig, turkey	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Argentina	Chicken, pig, turkey	Hygromycin B	0
Armenia	Cattle, chicken, sheep, pig, turkey	Ivermectin	1
Australia	Buffalo, Cattle, Goat, Sheep, Pig	Norgestomet	0,1
Belarus	Chicken, turkey	Ivermectin	1
Belize	Cattle	Clenbuterol	0,2
Bahrain	Cattle	Clenbuterol	0,2
Brazil	Cattle	Cabergoline	0,1
Cameroon	Cattle	Clenbuterol	0,2
Canada	Swine/Pig	Altrenogest	1
Chile	Cattle	Clenbuterol	0,2
China	Sheep	Flugestone acetate	0,5
Codex	Cattle	Clenbuterol	0,2
Colombia	Cattle	Clenbuterol	0,2
Costa Rica	Buffalo, Cattle, Goat, Sheep, Pig	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Dominican Republic	Buffalo, Cattle, Goat, Sheep, Pig	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Egypt	Cattle	Clenbuterol	0,2
El Salvador	Buffalo, Cattle, Goat, Sheep, Pig	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
EU	Bufalo, Cattle	Cabergoline, Clenbuterol	0,1
Fiji	Cattke	Clenbuterol	0,2
Japan	Buffalo, Cattle, Goat, Sheep, Pig, Turky	Norgestomet	0,1
Great Britain	Bufalo, Cattle	Cabergoline, Clenbuterol	0,1
Guam	Maiale	Altrenogest	1
Guatemala	Buffalo, Cattle, Goat, Sheep, Pig	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0

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Country	Products	Veterinary Drug	Threshold value
Gulf Cooperation Council	Cattle	Clenbuterol	0,2
Honduras	Buffalo, Cattle, Goat, Sheep, Pig, Turkey	Chlorhexidinem, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin	0
Hong Kong	Buffalo, Cattle, Goat, Sheep, Pig, Turkey	Furazolidone, Malachite green, Furaltadone,	0
India	Cattle	Clenbuterol	0,2
Indonesia	Buffalo, Cattle, Goat, Sheep, Pig, Turkey	Carbomycin, Nystatin, Phenothiazine, Sulfachlorpyridazine, Sulfaethoxypyridazine	0
Italy	Buffalo, Cattle, Turkey	Cabergoline, Clenbuterol, Ivermectin	0,1
Kenya	Cattle	Clenbuterol	0,2
South Korea	Cattle, Chicken	Norgestomet	0,2
Kuwait	Cattle, Turkey	Clenbuterol, Ivermectin	0,2
Macau	Cattle	Clenbuterol	0,2
Malaysia	Turkey	Nystatin	0
Mexico	Chicken, Goat, Sheep, Turkey,	Dexamethasone	0,75
Myanmar	Cattle	Clenbuterol	0,2
Nicaragua	Buffalo, Cattle, Goat, Sheep, Pig, Turkey	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Northern Ireland	Buffalo, Cattle	Cabergoline, Clenbuterol	0,1
New Zealand	Chicken, Goat, Sheep, Turkey, Buffalo, Bovine	Chloramphenicol	0,15
Northern Mariana Island	Chicken, Goat, Sheep, Turkey, Buffalo, Cattle	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Oman	Cattle	Clenbuterol	0,2
Panama	Cattle	Clenbuterol	0,2
Peru	Chicken, Goat, Sheep, Turkey, Buffalo, Cattle	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Philippines	Cattle, Buffalo	Clenbuterol,Cabergoline	0,2
Puerto Rico	Chicken, Goat, Sheep, Turkey, Buffalo, Bovine	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Qatar	Cattle, Buffalo,	Clenbuterol, Cabergoline	0,2

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Country	Products	Veterinary Drug	Threshold value
Russia	Chicken, Turkey	Ivermectin	1
Saudi Arabia	Cattle	Clenbuterol	0,2
Singapore	Cattle, Buffalo	Clenbuterol, Cabergoline	0,2
South Africa	Chicken, Goat, Sheep, Turkey, Buffalo, Bovine, Swine/pig	Aristolochia spp., Carbadox, Chloroform, Chlorpromazine, Colchicine, Dapsone, Diethylstilbestrol, Ipronidazole, Metronidazole, Phenylbutazone, Prednisolone	0
Thailand	Cattle	Trenbolone, Zeranol	2
Turkey	Cattle	Cabergoline, Clenbuterol	0,1
US Virgin Island	Chicken, Goat, Sheep, Turkey, Bovine, Swine/pig	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
United Arab Emirates	Cattle	Clenbuterol	0,2
USA	Chicken, Goat, Sheep, Turkey, Bovine, Swine/pig, Cattle	Chlorhexidine, Nystatin, Carbomycin, Hygromycin B, Penicillin, Sodium sulfachlorpyrazine monohydrate, Sulfomyxin, Sulfaethoxypyridazine	0
Vietnam	Buffalo, Cattle	Clenbuterol	0,2

Source: BCGlobal database

ii) Index

As indicated in the pesticides section, the distance in divergences in antibiotics regulation between the EU and its main trading partners is measured starting from Ferro et al. (2015) indicator.

$$AI\_vd_{EU-World(meat,veterinary)} = \frac{1}{N_{m,v}} \sum_{i=1}^{n} \frac{MRL_{i,m,v} - MRL_{j,m,v}}{Max(MRL_m) - Min(MRL_m)} \qquad (3)$$

where *i* stands for the exporter, *j* for the importer, *m* for the meat products, and v refers to veterinary drugs, which include antibiotics. The distance in antibiotics regulations ranges between -1 and 1. A value equal to 0 means that the EU and its main partners share the same regulation. A value greater than 0 implies a more stringent in the EU; conversely, a lesser value 0 indicates a less strict regulation for the EU. Even in this case, we must deal with the problem

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of missing values, as was the case with pesticides. Therefore, we must find the most suitable solution to interpret the missing values. In handling this problem, we apply the following rules:

1) If the exporting country's MRL is higher than the one of the importing country, the MRL will be applied at its maximum value.
2) If the exporting country's MRL is lower than the importer's, the importing country's MRL will apply. The exporting country should then make the maximum effort to meet the regulatory level imposed by the importing country.
3) The highest value of all substances found per product category will be used if the importing country regulates a specific substance and the exporting country does not.
4) If the exporter's MRL exists and that of the destination region is absent, the MRL imposed by the exporting country shall apply. In this case, the distance will be considered zero, and the exporter will not have to bear the costs of compliance with foreign regulations.
5) When both MRLs are missing, the maximum value is considered; in this case, the distance is regarded as zero.

Table 7: Rules for replacing missing values

MRL exporter	MRL importer	Rules
MRL exporter existing > MRL importer	existing	Max MRL
MRL exporter existing < MRL importer	existing	MRL importer
Missing	Existing	MRL exporter = Max MRL
Existing	Missing	MRL impoter = MRL exporter
Missing	Missing	MRL importer = MRL exporter = Max MRL

Source: Authors' elaboration on country's legislations

iii) Infographics

We compiled data at a detailed level, but for the presentation of results, we created eleven categories related to different product types within the same species. Specifically, we will discuss the results of beef, chicken, turkey, and pork. Our analysis includes the following

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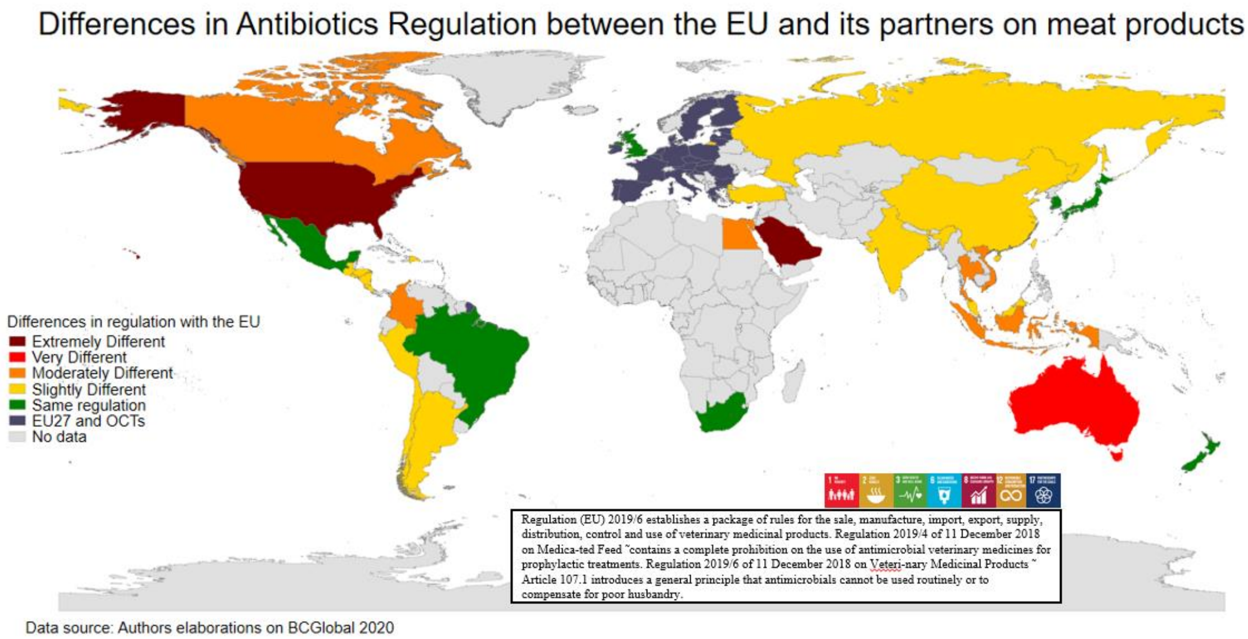
information: a) a general index computed considering all regulations regardless of the product; b) infographics[7] for beef, chicken, pork, and turkey.

Figure 15 shows the similarities or dissimilarities between the EU MS and other countries. Regions showing very different regulations on Antibiotics are Australia and North American countries, while those with similar regulations are South Africa, Mexico and Brazil.

Figure 15: Differences in antibiotics regulations at the Country Level



The heterogeneity evident at the country level is transferred to the product level. In this case, too, some are aligned with the EU regulation while others are very far from it. Countries with less strict regulations include the USA, Australia, Thailand, Laos, Vietnam, Gulf Cooperation Council, and Colombia. Meanwhile, South Africa and Mexico share MRL in antibiotics like the EU countries. Finally, China, India, Russia, Canada and Chile, for instance, report slight differences in regulating antibiotics with the EU region.

[7] https://zenodo.org/records/13847021

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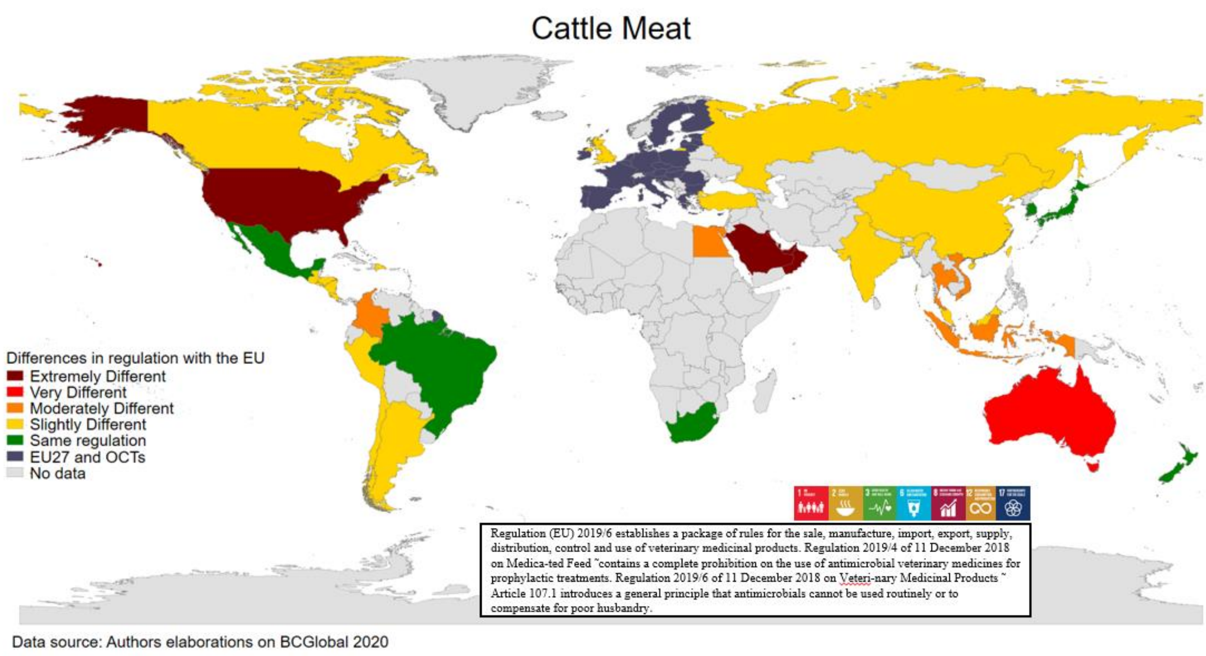
Figure 16: Differences in Antibiotics regulations on Beef Meat



Again, in the case of Chicken products, countries with less strict regulations include the USA, Australia, Thailand, Laos, Vietnam, Gulf Cooperation Council States, and Colombia. Meanwhile, South Africa and Mexico, Russia, Brazil and Japan share MRLs in antibiotics like those of the EU countries.

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Figure 17: Differences in Antibiotics regulations on Chicken Meat

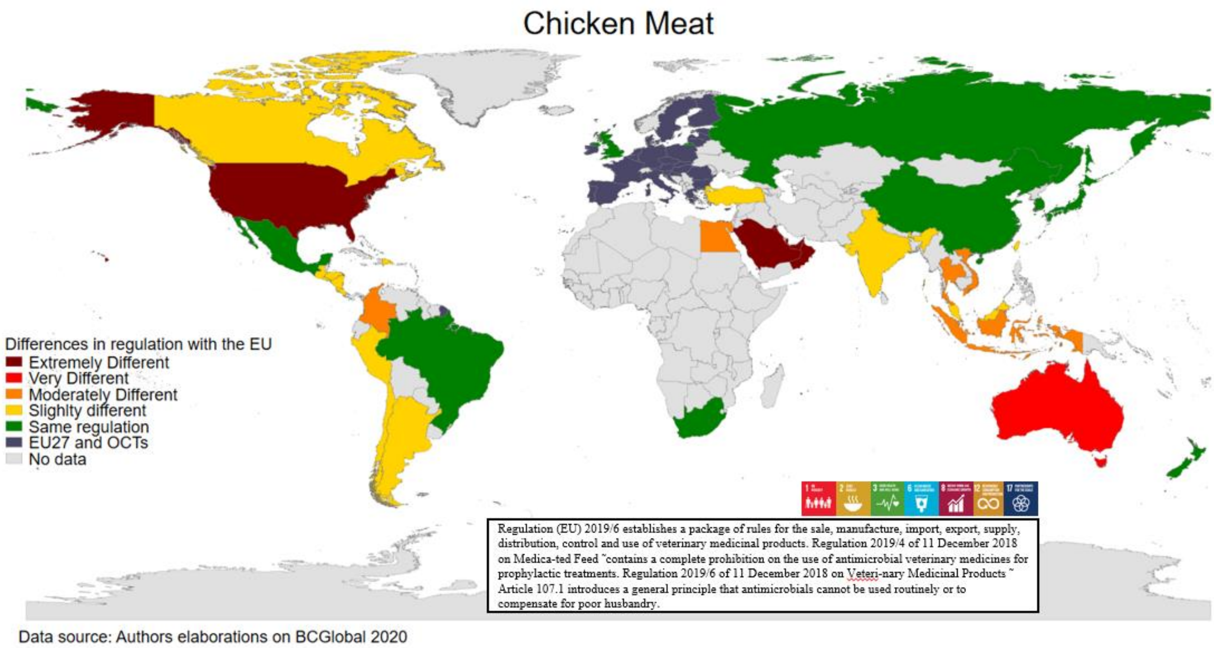

Figure 18 illustrates a quite comparable situation for swine meat. Once again, countries with less stringent regulations include North America, Australia, and Thailand. Meanwhile, South Africa, Mexico, Brazil, and Peru exhibit a similarity index equal to that of the EU MS. Slightly different results are reported for Russia, China, India, Chile, and Argentina.

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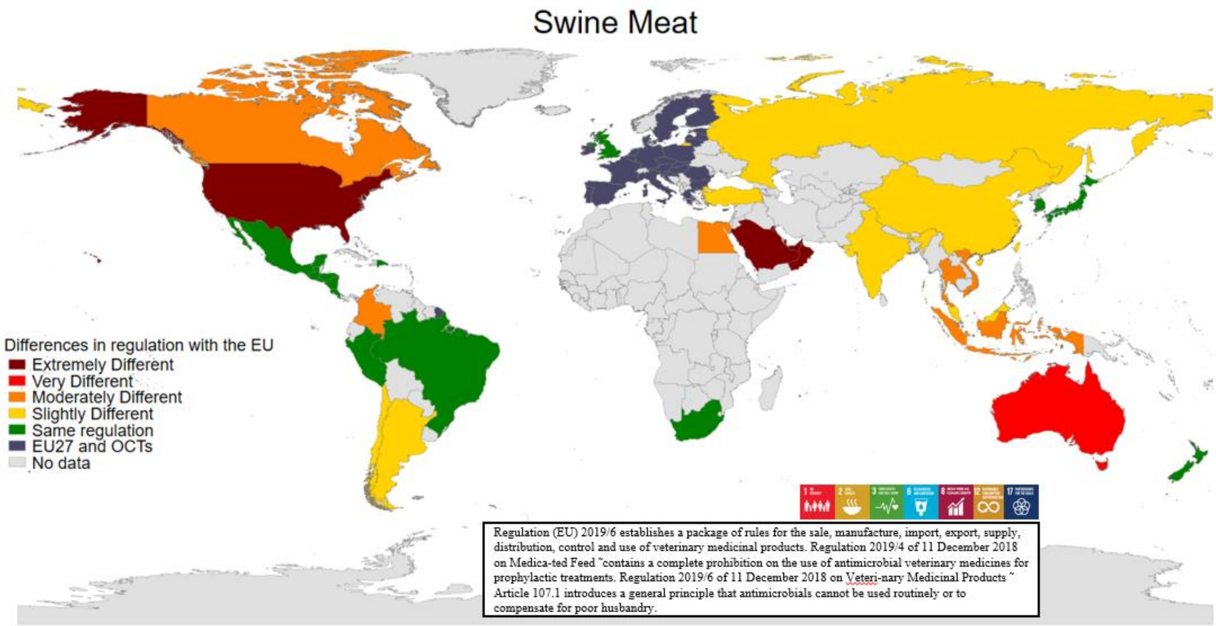
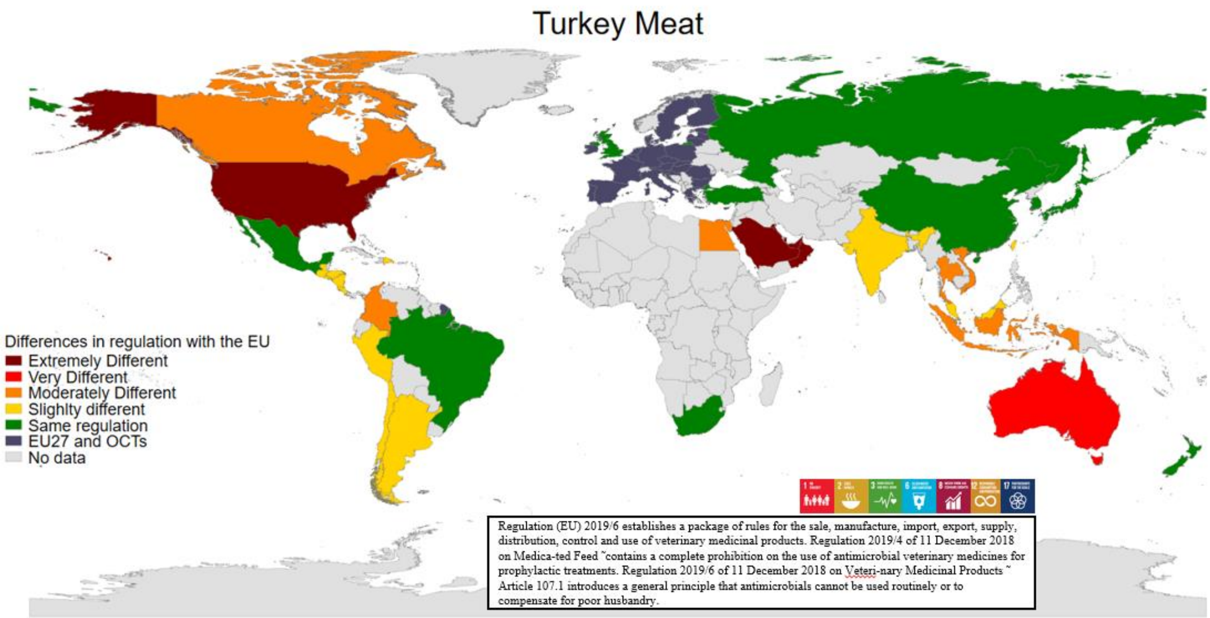
Figure 18: Differences in Antibiotics regulations at the Pork Meat



Data source: Authors elaborations on BCGlobal 2020

Even for turkey meat, countries with less stringent regulations include North America, Australia, and Thailand. Meanwhile, South Africa and Mexico exhibit a similarity index equal to the EU's.

Figure 19: Differences in Antibiotics Regulations on Turkey's Meat



Data source: Authors elaborations on BCGlobal 2020

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2.4 Conclusions on pesticides and antibiotics

We used two databases to develop different measures able to capture the differences in regulations of the UE and its partners. We contribute to the analysis of SPS measures by providing new evidence on the role of MRL stringency. Our results shed light a specific need for harmonisation for exporting countries with EU regulations. As varying effects depending on the type of toxicity class were observed in our analysis, a possible solution for future policy negotiations on SPS measures could be focusing on specific toxicity classes.

Our findings show that countries with stringent regulation tend to set strict MRLs regardless of the toxicity level, while nations with lax regulation vary their approach based on the toxicity of the substances. Additionally, results suggest that not considering toxicity classes can lead to a wrong measurement of divergences between countries' regulatory frameworks.

Results on harmonisation of standards reflect the discussion that has taken place over the years on food and health safety. As differences persist, further discussion is needed to boost harmonisation on standards, especially in antibiotics legislation. The application of stringent standards also requires several actions, such as technical assistance for the adaptation of farms to hygienic-sanitary standards and the correct use of antibiotics, as well as adequate surveillance and control structures. The ongoing liberalization process, through Free Trade Agreements (FTAs), should facilitate compliance between standards.

However, our conclusions cannot be generalized, as the analysis of the distance indicator suggests that, for each product, countries apply different policies in MRLs' management. Heterogeneity emerges both in the pesticides and antibiotics analysis, and harmonising standards could boost exports and improve food safety. This heterogeneity could be considered a barrier to trade, but further analysis is required to investigate this assumption (*e.g.*, gravity model approach).

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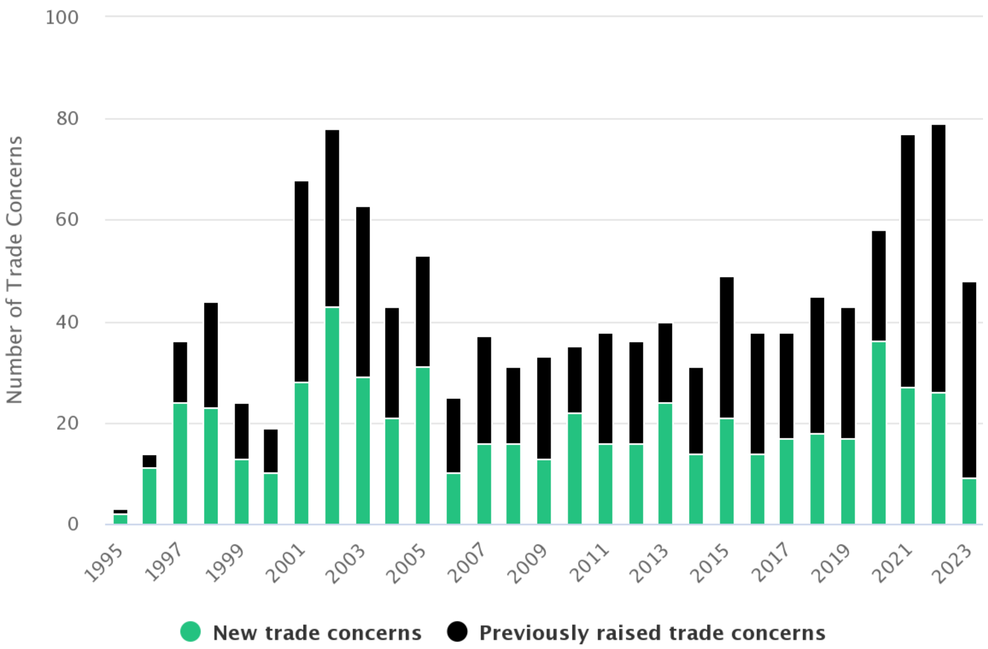
3. Specific Trade Concerns (STCs)

3.1 The importance of STCs in international trade

STCs are issues raised at the WTO by Countries affected by SPS standards, which they deem particularly restrictive.

Despite significant advances in developing global standards and joint conformity assessment (TBT and SPS Agreements), domestic and import regulations differ from country to country. The number of trade concerns raised by WTO members at the TBT and SPS Committee has grown over time. Discussing these concerns often allows members to reduce trade tensions before a measure enters into force and helps avoid escalation to a formal dispute. Currently, roughly 49.000 TBTs are notified compared to 32.370 SPSs (measures for the period 1995-March 2023).

Figure 20: Number of Trade Concerns raised by year on SPS



Source: WTO STC database

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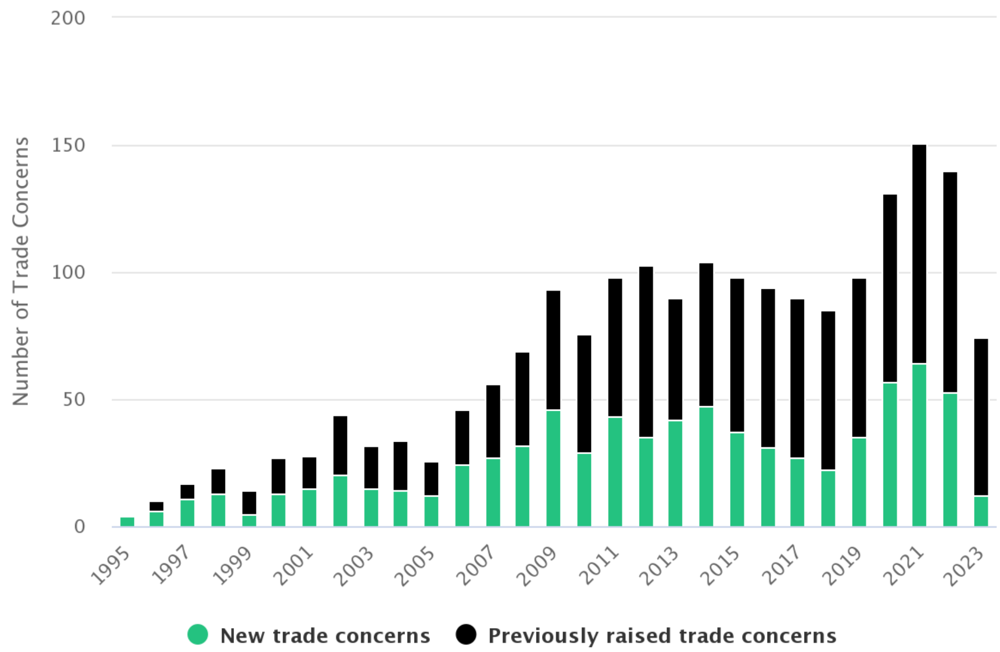
Figure 21: Number of Trade Concerns raised by year on TBT



Source: WTO STC database

The number of SPS and TBT notifications and the share of notifications submitted by developing countries have continuously increased. The number of STCs was particularly relevant between 2000 and 2005, probably due to the spread of animal disease outbreaks (e.g., BSE, Avian Influenza, etc.).

Each STC provides information on (i) the Country raising the concern and the Country imposing the measure; (ii) the year of the concern; (iii) the product of concern at the HS4 digit level; and (iv) the type of measure and the subject of the concern; (v) the eventual date of the resolution of the concern.

STCs are not formal disputes in the legal sense of the term but rather a way to seek information about others' implementation of regulation in light of international obligations.

Analysing STCs aims to identify potential problems that standards and their implementation pose for trade, as trading partners perceive.

The three STCs analysed focus on sustainability issues (e.g., food security, food safety, climate change, and animal health) that are directly and indirectly relevant to achieving several SDGs.

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The STCs analysed concern two of the "three sisters": WOAH and IPPC. The EU raised two, and one sees the EU as a respondent. All STCs are raised orally in the SPS Committee. No dispute has been opened. The Secretariat summarises progress in notes.

3.2 The three case studies

The three STCs differ in many respects: the role of the EU in the STC, the EU's position on trade, the international organisations involved in SPS, the sustainability issues involved, and the global dimension of the STC.

The EU-China case

The first STC analysis concerns China's import restrictions due to African swine fever (ASF) because of the lack of recognition of EU regionalisation. The sustainability issues involved are animal health and food security, which appears significant to meet the SDGs 1 (no poverty) and 3 (zero hunger) given that pork meat is one of the primary sources of animal proteins and China is the consumer of pig meat in the world. The EU raised this STC for the first time in July 2005 and eighteen more times, most recently in November 2023. China is imposing a country-wide ban on imports of pigs and pig products from EU MSs where ASF was detected, not recognising EU regionalisation applied following international standards established by WOAH (founded as Office International des Épizooties - OIE). Regionalisation allows the Country to limit the extension of the disease to a defined restricted area while preserving the status of the remaining territory and the continuation of the trade. The Chinese ban is also maintained on EU MSs that have regained disease-free status per the WOAH rules. The EU MSs currently affected by the Chinese ban are Poland, Hungary, and Belgium. EU considers Chinese measures overly trade-restrictive. On the other hand, China says the ban, imposed under the SPS agreement, is necessary considering the ineffective disease control by EU MSs with different levels of prevention and control. China highlights that in 2022 some EU MSs still suffer from ASF. China encourages bilateral applications from EU MSs for export licenses on the premise that the risk could be controlled. In December 2021, a regional management agreement for ASF between France and China was signed, becoming the first EU regionalisation recognition. The deal allows France pork exports from unaffected regions even if ASF occurred elsewhere in France.

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The EU- India case

The second STC concerns India's phytosanitary import restrictions due to the requirement for fumigation with methyl bromide (MBr) of plant and plant materials. The sustainability issue is climate change, and the SDGs involved are 1 (no poverty) as controlling pests is fundamental for local producers and 13 (climate action). The STC was raised by the European Union and the US (3 times all in 2004), supported by Canada, Chile, and New Zealand. MBr, as a fumigant, is recognised as an essential tool for controlling some quarantine pests of plants and plant-derived materials. At the same time, MBr is a potent ozone-depleting gas. For these reasons, MBr is regulated by two Multilateral Agreements:

a) the Montreal Protocol on Substances that Deplete the Ozone Layer.
b) the IPPC.

Production and consumption of MBr have been phased out by 2005 for developed countries and by 2015 for developing countries. An exemption to the ban exists for MBr for Quarantine and Pre-Shipment use, considering the necessity of its use where no alternative exists. Countries are, however, encouraged to use options to MBr where they are technically and economically feasible. In the EU, MBr for Quarantine and pre-shipment purposes has been banned (both production and consumption) since March 2010. EU does not allow fumigation with MBr in agricultural exports/imports. In 2022, the STC has been declared partially resolved with problems of harmonisation of procedures (as far as the EU is concerned).

The EU-Senegal case

The third STC has been raised by Senegal concerning EU mango imports. The STC has been raised by Senegal only one time in 2008. The sustainability issues involved are Food safety food security. All the SDGs are interested (1 – no poverty; 2 – zero hunger; 3 – quality education; 5 – gender equality; 8 – decent work and economic growth; 12 – responsible production and consumption) are related to the social and economic importance of mango sector in Senegal. In 2007, the EU rapid alert system warned that the limit for a post-harvest product had been exceeded (there was an interception of fruit fly (an invasive pest) in imported mangoes from Senegal). The fruit fly pest is a significant threat to the horticulture industry in Africa. The interception of fruit flies on mango imports from Senegal has been numerous and

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recurring. The mango sector in Senegal has grown dramatically in recent years, both in terms of production and exports. However, its potential remains underexploited due to the weakness of the production structures of the central Senegalese-producing regions. To strengthen measures to prevent the introduction and spread of harmful pests and diseases in the EU, on December 2019, a revised EU phytosanitary regime entered into force, imposing additional requirements on all countries exporting mangoes to the EU (a "crop-specific dossiers" is required as a prerequisite for exports to EU that impose a national action plan). Thanks to international technical assistance programs, the EU and Senegal are working together to modernise the mango sector, make it compliant with the new EU SPS regulation and to continue exporting to the EU, thus contributing to Senegal's sustainable economic growth and its potential to provide employment opportunities, particularly for women and young people, and to support rural communities by reducing poverty and ensuring decent work (Maertens, Swinnen, 2009). In 2022, STC has been declared resolved.

The three STCs highlight the different perspectives of partners involved in trade concerns and the various levels of awareness and needs regarding sustainability issues. From the analysis, we can identify three different behaviours regarding sustainability:

1) Divergent (EC-China case): The two trading partners pose divergent sustainability goals on the same issue (regionalisation), with China more focused on food security and the EU on economic concerns (specifically, the defence of its pig industry).
2) Negotiable trade-offs (EU-India case): The two countries present different sustainability objectives around the procedural issue. India is more focused on food security (specifically, controlling some quarantine pests of plants and plant-derived materials), while the EU prioritises climate change (specifically, the effects of MBr on the ozone layer).
3) Cooperative (Senegal-EU case): The two trading partners share the same sustainability goals, particularly the importance of the mango sector in contributing to Senegal's sustainable economic growth.

The three case studies demonstrate the importance of addressing the potential problems that standards and their implementation pose for trade and achieving sustainability goals. The recommended actions include: strengthening cooperation and information exchange between

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trading partners (as suggested by analysis of the EU-China and EU-India STCs); providing ongoing technical assistance programmes to help countries improve sustainability and compliance with norms and standards, including through effective dialogue and engagement between the public and private sectors, involving all stakeholders (as in the case of Senegal); and raising the level of ambition in bilateral economic and trade relations for sustainable development (China, India), moving from technical dialogue to a higher political level.

The STC mechanism aims to enhance cooperation, transparency, and surveillance, promote policy learning and best practices, engage economic diplomacy to clarify misunderstandings, create a dialogue between experts, and thus provide a space for cooperation (Santana, Dobhal, 2024; Fabri et al., 2023). Furthermore, this analysis suggests that STCs could be further improved to link trade and sustainability.

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