SOIL CONTAMINATION

Cadmium limits in phosphorous fertilizers

What is cadmium's impact on ecosystem services, agri-food, and health in Europe, and how can it be remedied?

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UNIVERSITÀ CATTOLICA del Sacro Cuore

OPERA RESEARCH CENTER

OPERA Research offers simple and pragmatic solutions to support European and national decision-making processes. Since 2010, the research center and think tank of the Università Cattolica del Sacro Cuore has been working with farmers, associations, NGOs, and governments to integrate sustainability in the agri-food sector. Our vision is to provide high-quality information and analysis on the latest developments in EU agri-food policy and promote a balanced dialogue between stakeholders. Using existing and new research, we develop, in collaboration with partners, clear and pragmatic approaches and nature-positive solutions for European agriculture.

OPERA Research would like to thank all Soil Health and Fertility Working Group members for their substantial input, constructive attitude, valuable suggestions in developing the white paper, and all the experts who contributed with their insights to the revision of the document.

The production of this document was made possible with the support of Safer Phosphates™.

OPERA Research, November 2021.

Foreword

Often invisible to the human eye, contamination affects many aspects of our lives. Soil contamination is a significant threat to soil health and fertility. It affects the quality of food, water, air and poses a threat to the environment and human health.

To ensure food security and nutrition around the world, we must cultivate and protect our soils.
Soil provides essential ecosystem services to a rapidly growing population and deserves protection from degradation, yield reduction, and contamination, such as cadmium (Cd) residues in phosphate fertilizers, endangering its health.
Judicious use of phosphate fertilizers increases agricultural productivity, reduces the need to cultivate additional land, helps prevent soil degradation and crop failures.
EFSA[1] and ANSES[2] opinions clearly show that phosphate fertilizers with high Cd content lead to accumulation in the soil and transfer to the food chain of this ubiquitous and highly toxic contaminant that can cause serious harm to the environment and human health.
Despite a lively scientific discussion and political debate, decisive measures to minimize Cd in fertilizers, its accumulation in the soil, and its transfer to crops have been lacking in Europe for about three decades.
OPERA joins the many voices calling for urgent action to recommend the sale of exclusively low Cd fertilizers, make Ecolabels and Green Stickers informative and precise, and invest in training and extension programs for farmers.

Prof. Ettore Capri
Director, OPERA Research

INDEX

Summary

Cadmium (Cd) is a heavy metal that accumulates in soil and living organisms and causes severe and permanent damage. Its presence in the soil depends largely on the use of **phosphate fertilizers**[3]. Phosphate fertilizers are produced from phosphorite and apatite rocks that contain several other minerals, including Cd, in addition to phosphate dioxide. The amount of Cd incorporated in phosphate fertilizers depends on the type of phosphorite and apatite rocks (with low or high Cd content). When Cd comes into contact with the soil, the organic matter retains it and makes it readily available to plants.

European soils exhibit ideal characteristics for Cd accumulation due to mild temperatures and prolonged summer drought. In addition, the high mobility of Cd in surface and groundwater can cause point contamination to turn into diffuse contamination rapidly.
Once crops absorb Cd, it enters the food chain.

Food is the primary source of Cd exposure (for the non-smoking population)[5/6], with cereals, nuts and legumes, starchy roots, potatoes, and meat being the major contributors. Progressive accumulation of Cd in humans impairs kidney function, affects the liver, and causes bone demineralization.

Cd classification as a human carcinogen goes back to the 1990s. The European Union adopted Regulation (EU) 2019/1009, limiting Cd content in phosphate fertilizers at 60 mg/kg.
The ban on the commercialization of phosphate fertilizers with a content of more than 60 mg/kg will enter into force on July 16, 2022. This threshold seems inadequate compared to the threshold values for Cd in some EU countries: 12 member states have a Cd threshold between 20 and 50 mg Cd/kg P2O5, 8 have the same threshold as proposed in the regulation, and 2 have a higher threshold.

Fertilizers with low Cd content, with thresholds no higher than 20 mg Cd/kg P2O5, would effectively limit bioaccumulation[7]. Meanwhile, the forthcoming new CAP agreement explicitly references soil health and fertility protection and the limitation of contaminants in fertilizers[8].

Furthermore, the European Parliament's October 2021 Farm to Fork Strategy report emphasized that heavy metals should be part of fertilizers' sustainable use assessment.

It is about time to introduce a combination of hard and soft legislation for Cd, including a regulation with strict thresholds and accurate labeling, subsidies for farmers, and incentive systems for value chain actors that promote voluntary schemes.

Cadmium limits in phosphorus fertilizers

Soil contamination is a significant threat to soil health and fertility. It affects the quality of food, water, air and poses a threat to the environment and human health.

What is **cadmium**?

Cd
Cadmium

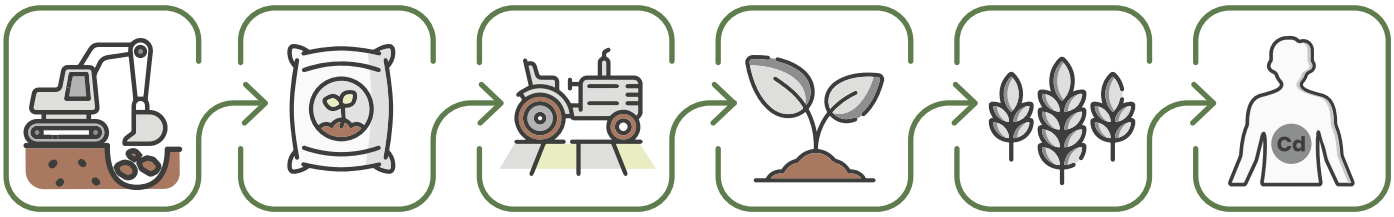
Cadmium (Cd) is a heavy metal that accumulates in soil and living organisms and causes severe and permanent damage to them. The presence of cadmium in soils depends largely on the use of phosphate fertilizers. Once crops absorb **Cadmium through fertilizers, it enters the food chain.**

In Europe and Eurasia, soil pollution is the third most relevant environmental threat. Copper (used as a plant protection product) and Cadmium (associated with phosphate fertilizers) are the most common and widespread contaminants in European agricultural soils.

Food is the primary source of cadmium exposure, with **cereals, nuts and legumes, starchy roots, potatoes, and meat** being the major contributors.

Progressive accumulation of Cd in humans **impairs kidney function, affects the liver, and causes bone demineralization.**

Life cycle of Cadmium in phosphorus fertilizers



Mining of phosphorus ore and stewardship of local resources and communities

Production of phosphorus fertilizers

Use of phosphorus fertilizers

Bioccumulation, mobility, and bioavailability of cadmium in soil

Cadmium absorption by crops and bioaccumulation in edible parts

Cadmium bioaccumulation in human body

What is being done?

The European Union will ban the commercialization of phosphate fertilizers with a content of **more than 60 mg of Cadmium per kg in July 2022.**

Fertilizers with low Cadmium content (no higher than 20 mg/kg) would be more powerful in limiting the process of contaminants entering the food.

This is not enough. **What needs to be done?**

1. **Introducing the harmonized European** 'tolerance threshold' for Cadmium at the lowest possible level (20mg/kg)
2. **Introducing clear labelling** for phosphorus fertilizers
3. **Stimulating farmers to use lower Cadmium fertilizers** through CAP subsidies, education and other incentives
4. **Creating an environment that allows adjacent sectors** to contribute to continuous improvements through voluntary measures
5. **Expanding and harmonizing soil and water** monitoring systems in Europe

The issue at stake

Several studies point to the impact of mineral fertilizers[9] as a significant source of cadmium (Cd) contamination in agricultural soils and, consequently, in Europeans' diets.
Cd is a toxic contaminant that can have severe and often irreversible effects on human health[10] and natural ecosystems[11/12/13].
The application of mineral phosphorus (P) fertilizers is mainly responsible for the accumulation of Cd in agricultural soils and watersheds[14].

45%
Cd contamination of cropland by P fertilizers

Accumulation in the soil increases Cd levels in plants and the potential for humans to ingest amounts that exceed the level at which no adverse health effects occur[15/16/17/18/19/29/21/22].
In addition, Cd can enter freshwater reservoirs and animal feed[23/24/25/26].
In Europe, mineral P fertilizers contribute 45% of the total Cd contamination of cropland. At the same time, 55% of the total dietary Cd intake of the average European consumer is related to Cd accumulation in soil[27/28/29/30].

The long-term consequences of Cd contamination on the soil ecosystem are not entirely predictable[31/32/33].
Moreover, some studies show that even diffuse contamination at low concentrations, in the presence of efficient Cd transfer from soil to plants, can lead to Cd accumulations in edible parts of plants that exceed the values recommended for human consumption. And even when plants do not show toxicity symptoms[34]. These uncertainties alone would suggest that introducing stricter limits that can reduce the overall effects of Cd accumulation, pollution of agricultural soils, and European natural ecosystems is an adequate solution to the problem[35/36].

In this context, Regulation (EU) 2019/1009 is an essential step because it helps set stricter thresholds for Cd in fertilizers and limits bioaccumulation in agricultural soils.
However, considering the latest scientific evidence and monitoring data, we cannot help but consider the measure insufficient to address the Cd risk fully.

What is cadmium

Cadmium (Cd) is a silvery-white, soft and ductile metal. It is relatively rare in nature and belongs with other 20 minerals to the so-called “heavy metals” group, a name derived from the high molecular weight typical of these elements[2]. It can be released into the environment through natural activities (such as erosion, river transport, and volcanic activity) and, above all, from the use of phosphate fertilizers, capable of generating diffuse and point source pollution[37].

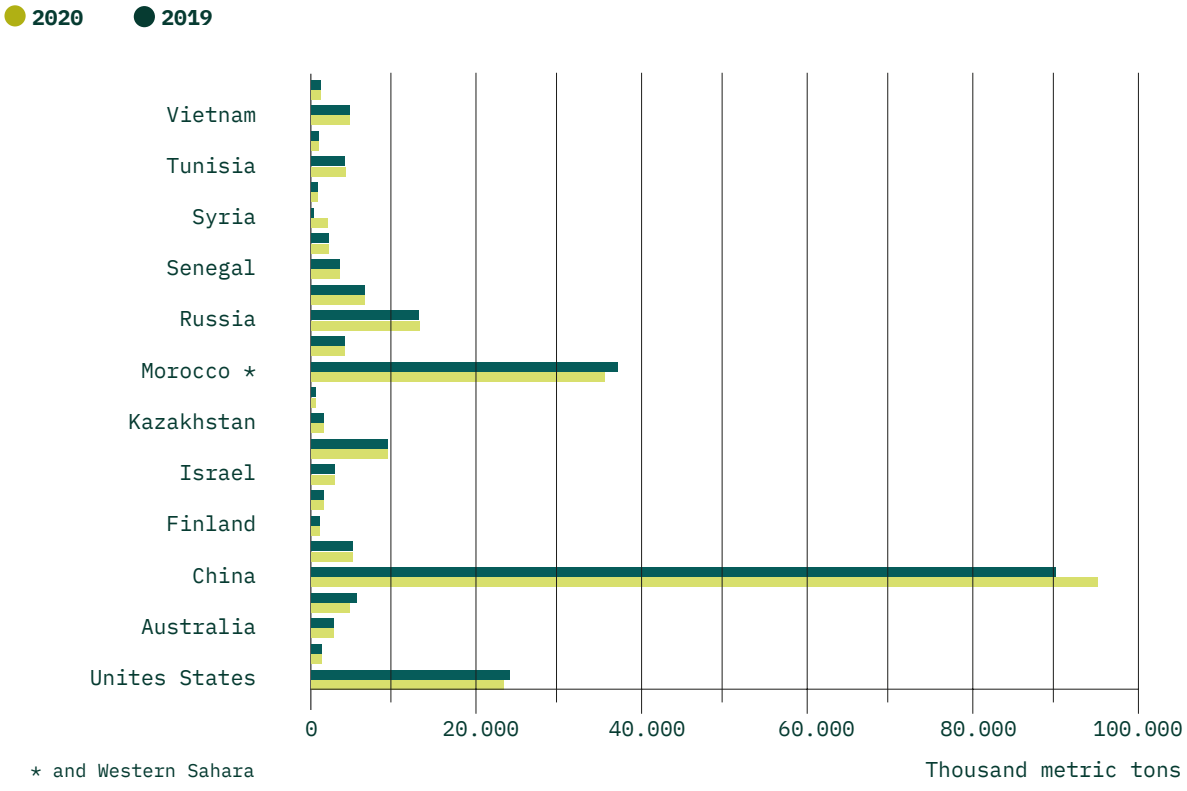
Cd is the third most dangerous pollutant for the environment, after mercury (Hg) and lead (Pb). It is bio-persistent, and once absorbed by an organism, it can remain in it for many years. The US Environmental Protection Agency (US EPA, 2021) and the International Agency for Research on Cancer (IARC 2021) classify Cd as a human carcinogen because of its ability to accumulate in the body and cause severe and permanent damage.

Why do fertilizers contain cadmium

Cadmium (Cd) in phosphate fertilizers depends on phosphate rocks (apatite and phosphorite), typically containing phosphate dioxide (P2O5), lime, clay, gypsum, dolomite, silica, and various other minerals, including heavy metals and metalloids like Cd, Pb, and arsenic (As). During the manufacturing process of phosphorus fertilizers, these impurities are incorporated, together with phosphates, into the final product.

Different types of phosphate rocks[38] have different levels of Cd. Cd is present in significant amounts in fertilizers produced with

PHOSPHATE ROCKS EXTRACTION ACCORDING TO UNITED STATES GEOLOGICAL SURVEY 2020



(United States Geological Survey, Mineral Commodity Summaries, January 2020)

minerals that are already naturally high in Cd. The production of phosphate fertilizers from rocks with low Cd content would always lead to products with low Cd content[39].

Cadmium is present in all phosphate rocks.
However, concentrations vary according to the origin of the rocks. Igneous or apatite rocks have very low cadmium concentrations (even less than 1 mg per kg P2O5). While sedimentary rocks contain cadmium at concentrations ranging from less than 20 to more than 200 mg per kg P2O5[40].

CADMIUM CONTENTS OF PRIMARY COMMERCIAL PHOSPHATE ROCKS ACCORDING TO DIFFERENT SOURCES[40]

Origin	Cadmium content (mg per kg P2O5)		
IGNEOUS	**(1)**	**(2)**	**(3)**
Kola (Russia)	< 13	0.3	0.25
Phalaborwa (South Africa)	< 13	0.1	0.38
SEDIMENTARY			
Florida (USA)	23	19.8 - 32.7	24
Jordan	< 30	12.01.28	18
Khouribga (Morocco)	46	17 – 63	55
Syria	52	13 – 46	22
Algeria	60	42 – 62.6	
Egypt	74		
Bu-Cra (Morocco)	100	101 – 115	97
Nahal Zin (Israel)	100	81 – 112	61
Youssoufia (Morocco)	121	164.7	120
Gafsa (Tunisia)	137	94	173
Togo	162	164 – 179	147
North Carolina (USA)	166	125	120
Taiba (Senegal)	203	165 – 180.6	221
Nauru	243		

Sources: ***(1)*** *Davister (1996);* ***(2)*** *Botschek and Van Balken (1999);* ***(3)*** *Demandt (1999).*

How soil retains cadmium

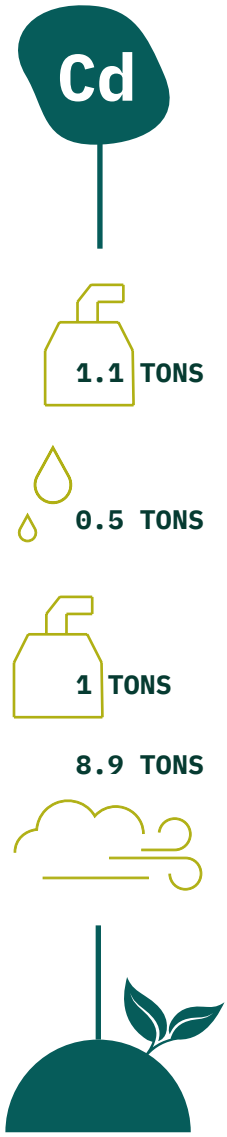
When a phosphorus fertilizer comes into contact with soil, it undergoes various biochemical, microbiological, and physical processes through which it is progressively degraded, reduced, and retained in the soil. The contaminants in the fertilizer follow the same destiny[41]. The ability of the soil to retain substances is the reason why accumulations of harmful compounds occur[42]. In the case of Cd, both the organic matter and the clay play an essential role in the absorption and retention capacity of the soil, while sandy soils facilitate Cd entering groundwater and rivers[43].

Depending on soil and climate characteristics, different ecosystems have different degrees of resilience in resisting possible damage, as they can recover from contamination and regenerate over time. However, spontaneous and natural regeneration can be more complex in the presence of external pressures that constantly alter the responsiveness and adaptive capacity of the ecosystem[44/45], such as a continuous fertilization process protracted over the years in all rural districts in Europe.

+ 1 %

The Scientific Committee on Toxicity, Ecotoxicity, and the Environment (CSTEE) estimated that the annual net accumulation of cadmium (Cd) in the soil is about 1% of the amount already present in agricultural soils.

Accumulation of cadmium in the soil



In 2002, the Scientific Committee on Toxicity, Ecotoxicity, and the Environment (CSTEE) estimated that the annual net accumulation of cadmium (Cd) in the soil is about 1% of the amount already present in agricultural soils. The European Member States that conducted specific risk assessments concluded that the annual net accumulation by phosphate fertilizers alone (with an estimated Cd content of 60 mg/kg P2O5) is between 0.4 and 1.25% of that already present in agricultural soils.

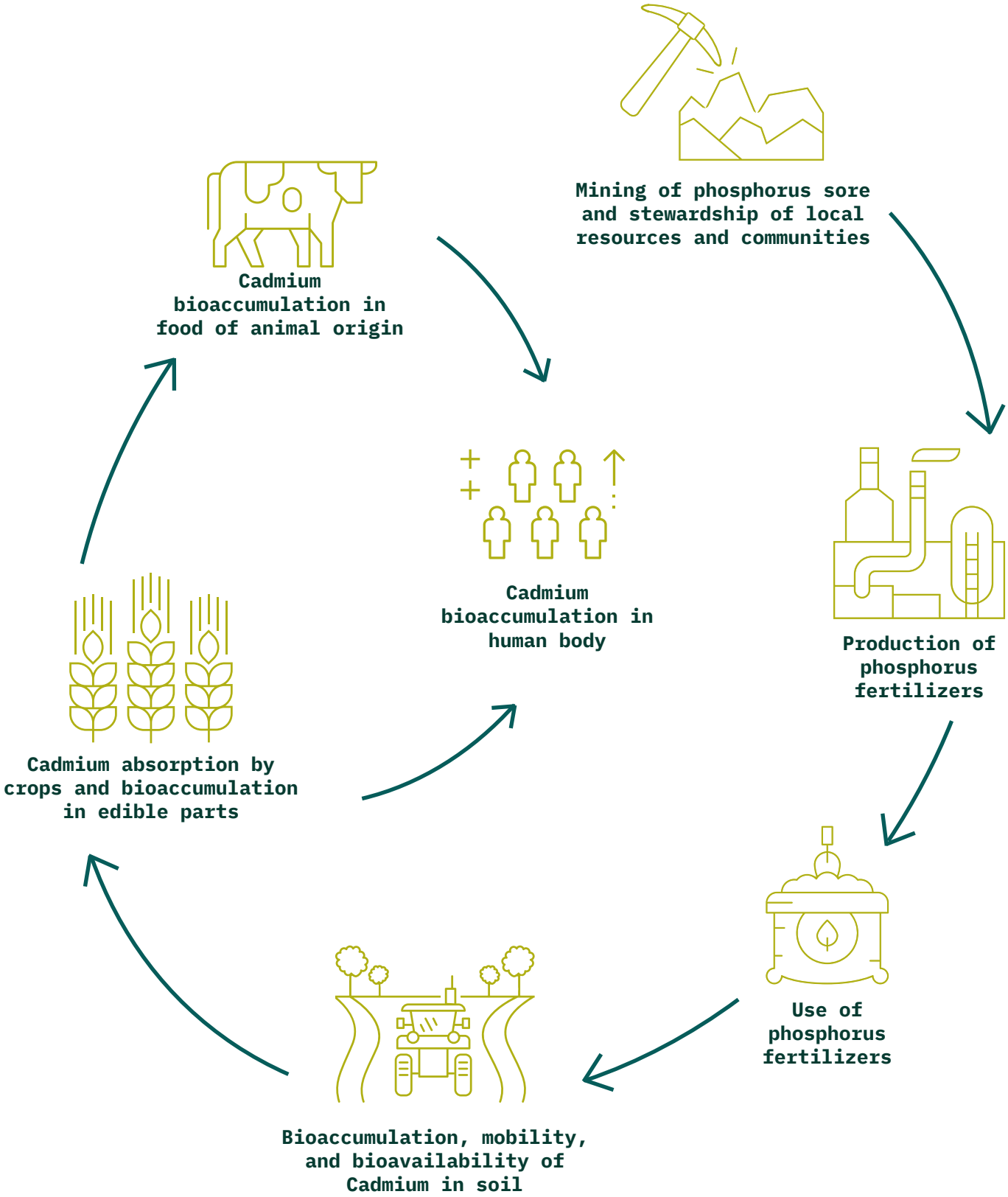
Literature also shows how the contribution of Cd contamination from phosphate fertilizer application to agricultural land dangerously overlaps with that from other sources.
An estimate of Cd contamination in Switzerland in 1990 shows that about 1.1 tons of Cd were added to agricultural soils annually through mineral fertilizers, 0.5 tons through sewage sludge, 1 ton through organic fertilizers, and 8.9 tons through atmospheric deposition[46].

Factors such as Cd levels, climate, soil pH, organic matter, salinity, tillage, macro-and micronutrients, type of parent rock, crop species, and varieties play essential roles in soil bioaccumulation and result in long-term effects on ecological systems and the health of living organisms.
In Europe, due to mild temperatures and prolonged summer droughts, Cd is more likely to accumulate in the surface layers of the soil. There, the significant presence of microfauna and root pili that can efficiently facilitate absorption of mineral nutrients[47].

How crops absorb cadmium

Despite being a non-essential element for plant organisms, Cd has a high transfer rate from soil to plant. Its behavior is very similar to that of zinc (Zn), an element that is necessary for good plant and human development. When the soil has an insufficient mineral supply of Zn to meet the crop's needs, the similarity between the two elements causes the plant to take Cd instead of Zn[48].
Moreover, organic matter can fix mineral elements, making them readily available to plants. For this reason, it significantly affects the ability of plants to absorb Cd, as the root system preferentially develops in superficial horizons where its presence is usually more pronounced.

Cd contamination is a significant stressor for plants that may cause cytotoxic and genotoxic effects and negatively affect growth and reproductive potential[49].
A widespread low concentration of soil contamination together with efficient transfer of Cd from soil to plants means that even in the presence of low levels of contamination, and even if the plants do not exhibit symptoms of toxicity, the edible parts of plants may exhibit Cd accumulations higher than those allowed for human consumption[50]. This effect may be most significant for crops growing in aquatic ecosystems[51].



LIFE CYCLE OF CADMIUM IN PHOSPHORUS FERTILIZERS

Monitoring soil status

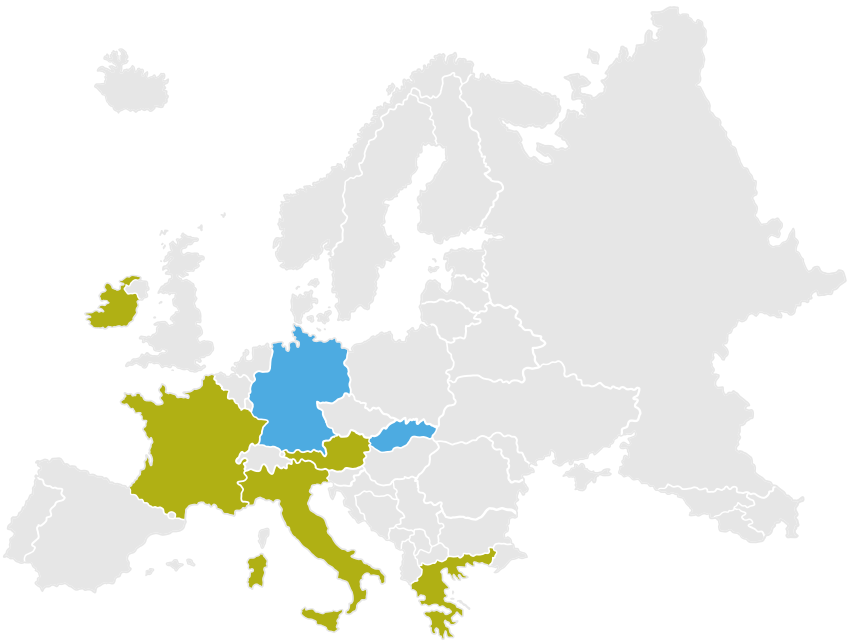
In Europe and Eurasia, soil pollution is the third most relevant environmental threat[52].
According to the latest data published by the European Environment Agency (EEA 2021), contaminated or potentially **contaminated sites in Europe are more than 2.5 million**[53], with the most frequent contaminant being heavy metals.

European monitoring programs show widespread contamination in surface waters (Germany, Slovakia) and soils (Greece, Italy, France, Austria, Ireland)[54]. Further analysis shows that copper (Cu) (used as a plant protection product) and Cd (associated with phosphate fertilizers) are the most common and widespread contaminants in European agricultural soils (EEA, 2010).

2.5 mls
CONTAMINATED SITES IN EUROPE

contamination in surface waters
Germany, Slovakia

contamination in surface soils
Greece, Italy, France, Austria, Ireland

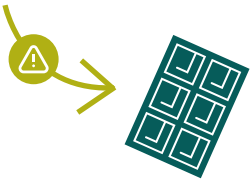


The impact of cadmium on human health

Scientific literature identifies cadmium (Cd) as a non-essential element for living organisms. Cd is primarily toxic to the kidneys, to the liver, can cause bone demineralization, and is classified as a human carcinogen (IARC, 2021; EFSA, 2021; ANSES, 2021).

Foods are the primary source of Cd exposure[55/56/57]. Cereals, vegetables, nuts and legumes, starchy roots and potatoes, and meat are the major contributors to human exposure. High concentrations also occur in algae, fish and seafood, dietary supplements, mushrooms, and chocolate. Given the lower average intake, these are not usually significant sources of exposure.

However, chocolate does become relevant when it comes to intake by children.



How EU fertilizer policy reflects the issue

The European Union has been concerned about Cd since the 1970s, but it was only in **June 2019**[59] that the EU officially adopted Regulation 2019/1009, which introduced **limits on the Cd content in phosphorus fertilizers set at 60 mg/kg**[60].

With this provision, the EU leveraged the regulatory principles of precaution and standstill raised during the discussion of the provision by setting a threshold based on estimated average Cd accumulation in EU soils and not including a continuous reduction plan. Bioavailability (for uptake by crops), mobility, and potential contamination of surface and groundwater may not have played an equal role in the assessment, which consequently left out many of the environmental and human health concerns raised during the discussion of the provision[61/62/63/64/65/66].

Moreover, a **threshold value of 60 mg/kg P2O5 was already under scrutiny after the 2002** opinion of the Scientific Committee on Toxicity, Ecotoxicity and the Environment and wholly superseded by the model developed by Römkens in 2018, which predicts that Cd accumulates even at a threshold value of 20 mg/kg P2O5[67].

How other EU Regulations reflect the issue

The EU would like to be considered the most active region in soil protection and conservation[68/69/70/71], but despite the political importance attached to the issue, soil-related measures are the sole responsibility of Member States. Generally, they do not have a coherent regional approach. Moreover, the EU lacks a comprehensive and legally binding legislative regime dedicated to soil (Castelo-Grande et al., 2018), and this despite the interaction of different contextual legislative frameworks (CAP, Water Directives, Nitrogen Directive) that regulate soil and fertilizers, but with constrained results[72/73/74/75/76].

EU and MSs national cadmium limits

Harmonized rules provide a transparent and predictable legal framework for all businesses (e.g., agricultural technology providers, farmers, food processors, and distributors), which is a prerequisite for healthy competition and greater awareness along the value chain of risks and risk mitigation strategies.

The maximum threshold of 60 mg/kg P2O5 will come into force in 2022 in an EU where 12 MS already adopt lower threshold values, 8 MS have similar values, and 2 MS have set higher thresholds[77] so that it is challenging to consider it a breakthrough or a harmonization of the internal market[78]; (Schroeder, Anggraeni and Weber, 2019)[79].

Harmonized rules provide a transparent and predictable legal framework for all businesses (e.g., agricultural technology providers, farmers, food processors, and distributors), which is a prerequisite for healthy competition and greater awareness along the value chain of risks and risk mitigation strategies.

How the CAP review process reflects the issue

In October 2020, the European Parliament successfully adopted a few amendments[80] during the current CAP review process, linking the CAP to reducing heavy metals in fertilizers. The text was part of the European Parliament's negotiating position with the Council. In June this year, EU agriculture ministers confirmed the preliminary agreement with the European Parliament on CAP reform.

On September 9, 2021, the European Parliament's AGRI Committee approved by a large majority the complete CAP package agreed upon during the informal trialogue in June. The preliminary agreement contains an explicit reference to protecting soil health and fertility and reducing pollutants in fertilizers.
To the extent that the current provision appears in the final agreement, financial incentives to farmers could require the use of low-Cd phosphates[81].

RECOMMENDATIONS

Soil is particularly vulnerable, and with it, our agri-food systems and our health as consumers.

We must pursue ambitious approaches to both continuing to improve fertility and control contamination. We need a combination of hard and soft law:

- **To set harmonized European thresholds** in phosphorus fertilizers to protect the most vulnerable environments and populations.
- **To stimulate farmers** to improve use and management practices continuously.
- **To create an environment** that allows adjacent sectors to contribute to continuous improvements through voluntary measures.

In practice, it would be necessary for the EU to rethink the effectiveness of Regulation (EU) 2019/1009 by including tight thresholds for Cd and precise labeling for phosphorus fertilizers, revisit CAP's cross-compliance and incentive systems to favor a minimum standard and voluntary schemes[82].

The EU should set the 'tolerance threshold' at the lowest possible level (e.g., 20mg/kg)[83], considering both the availability in many deposits around the world of phosphate minerals with low Cd content[84] and the developments in extraction methods that are constantly being improved and allow for a reduction in the number and quantity of impurities[85].

Conclusions

Soil health and fertility and their impact on food safety and public health have been of concern in recent decades due to the growing understanding of the degradation and contamination of European soils.
Soil quality and consumer health are at risk due to the bioaccumulation of cadmium (Cd) in soils and the bioavailability of Cd in organic matter. Accumulation depends mainly on the use of phosphate fertilizers with high Cd content. The bioavailability depends on the same natural soil composition, water richness, and mild climate, making Europe a fertile land with high productivity and vibrant agrobiodiversity.

Moreover, due to the high mobility of Cd in surface and groundwater, a local problem is quickly turning into widespread contamination.

Limiting bioaccumulation is possible through phosphorus fertilizers with low Cd content; clear labeling; subsidies and incentives for farmers related to the use of low Cd fertilizers; incentives for voluntary initiatives by value chain operators; soil and water monitoring.

Together, these programs will promote the proper management and mitigation of the effects of Cd contamination.
More research on fertilizer production methods and soil health and fertility are critical to developing appropriate measures to prevent or mitigate potential harm.
There is also a need to expand, improve and harmonize monitoring systems in Europe.

Work to achieve this goal is progressing steadily. Recent policy discussions and agreements to include this topic in the CAP are moving in the right direction. The European Union is very close to refining its approach to soil and human health to make it consistent with its long-term vision and goals and compatible with the needs of the agri-food sector. However, this is a critical time when all stakeholders are called upon to support this crucial transformation of European food systems.

Finally, we cannot overemphasize the importance of labeling, education on the sustainable use of fertilizers, and communications. Modern agriculture requires better technical knowledge and skills for on-farm application and better communication to maintain consumer confidence.

NOTES

[1] https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2009.980

[2] https://www.anses.fr/fr/system/files/VSR2015SA0140.pdf
[3] Global assessment of soil pollution: Report, FAO and UNEP, 2021, http://www.fao.org/documents/card/en/c/cb4894en

[4] Apatite and phosphorite represent the most significant natural phosphate mineral formations groups and occur in igneous rocks and sedimentary deposits, respectively.
The vast majority of the world's annual rock phosphate production (47 million tons) comes Literature includes data on more than 1,600 phosphate deposits, mines, and occurrences
from sedimentary deposits. Large (sedimentary) deposits exist in North Africa, China, the Middle East, and the United States, and (igneous deposits) in Brazil, Canada, Finland, Russia, and South Africa. In addition, the continental plateaus, and seamounts of the Atlantic and Pacific Oceans contain significant phosphate deposits. The world's supply of rock phosphate exceeds 300 billion tons, and there is no forecasted shortage. USGS Phosphate Rock Statistics and Information, 2021, https://www.usgs.gov/centers/nmic/phosphate-rock-statistics-and-information
Cooper, J., Lombardi, R., Boardman, D. and Carliell-Marquet, C., 2011. The future distribution and production of global phosphate rock reserves. Resources, Conservation and Recycling, [online] 57, pp.78–86. https://doi.org/10.1016/j.resconrec.2011.09.009

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[7] According to the Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE), fertilizers with 20 mg Cd/kg P2O5 or less in most soils are not expected to lead to long-term accumulation in the soil: https://ec.europa.eu/health/ph_risk/committees/sct/documents/out162_en.pdf.
The interinstitutional agreement on the new EU Common Agricultural Policy (CAP) reached between the EU Council and European Parliament during the summer 2021 explicitly calls EU Member States to intervene, as part of CAP Strategic Plans, to reduce soil contaminants. Such intervention, via CAP subsidies, should reward the use of low-cd fertilizers – particularly in the production of staple crops such as cereals and rice.

[8] The interinstitutional agreement on the new EU Common Agricultural Policy (CAP) reached between the EU Council and European Parliament during the summer 2021 explicitly calls EU Member States to intervene, as part of CAP Strategic Plans, to reduce soil contaminants. Such intervention, via CAP subsidies, should reward the use of low-cd fertilizers – particularly in the production of staple crops such as cereals and rice.

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A possible EU wide charge on cadmium in phosphate fertilisers: Economic and environmental implications Final Report to the European Commission, 2000).

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Soil Degradation (GLASOD), 2021);(de Ploey, Imeson and Oldeman, 1991).
de Ploey, J., Imeson, A. and Oldeman, L.R., 1991. Soil Erosion, Soil Degradation and Climatic Change. In: F.M. Brouwer, A.J. Thomas and M.J. Chadwick, eds. Land Use Changes in Europe, The GeoJournal Library. [online] Dordrecht: Springer Netherlands.pp.275–292. https://doi.org/10.1007/978-94-011-3290-9_12.

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[55] The EU's monitoring program shows that cadmium can be found in measurable and often high levels in vegetables across Europe. Recent revisions to the maximum permissible limits of cadmium in food, has prevented several products from being imported into the EU. These include cocoa and chocolate from Peru due to high cadmium content in local soils (Chavez et al., 2015);(Engbersen et al., 2019).
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[56] In July 2021, as part of the French human biomonitoring program, the results of a cross-sectional survey called Esteban (Étude de santé sur l'environnement, la biosurveillance, l'activité physique et la nutrition) , based on a representative sample of the French population, were presented. Esteban is a French national public health study that aims to measure population exposure to heavy metals, focusing on dietary habits and chronic diseases. The results showed that cadmium was present in 100% of the adults and children participating in the study. In children, breakfast cereal consumption increased cadmium intake, mainly due to cadmium-rich phosphate fertilizers used in conventional agriculture and daily consumption of these cereals. In nonsmoking adults, consumption of shellfish was the primary source of exposure (https://www.santepubliquefrance.fr/presse/2021/exposition-aux-metaux-de-la-population-francaise-resultats-de-l-etude-esteban).

[57] In Italy, the Umberto Veronesi Foundation has been pointing out for several years that some heavy metals can reach higher concentrations in the blood and urine of people following a gluten-free diet. According to the foundation, the higher intake of heavy metals (arsenic, cadmium, lead and mercury) in a gluten-free diet is related to the higher consumption of rice (arsenic and cadmium) and fish (mercury).

[58] Some authors (Leita and Ciavatta, 2017) refute the immediate need for action in this area, arguing that incremental accumulation on an annual basis is unlikely to be a short-term human health concern.
Leita, L. and Ciavatta, C., 2017. Cadmio nei fertilizzanti fosfatici: allarmismo ingiustificato. Georgofili Info.

[59] On the 5 June 2019, after 3 years of intensive interinstitutional negotiations between the European Parliament and EU Council.

[60] In addition, a voluntary 'green label' was foreseen for phosphorus fertilizers with a level of cadmium content below 20 mg/kg. A detailed Guidance Document was published by the European Commission early 2020, allowing responsible companies to adopt this label. Finally, Member States wishing to maintain stricter national limit values for cadmium content which are equal to or lower than those limit values are applicable at Union level, can continue to do so after the entry into force of the regulation on 16 July 2022.

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[76] On November 17, 2021, the European Commission should adopt the revised EU Thematic Strategy on Soil: https://ec.europa.eu/environment/soil/three_en.htm. The ongoing discussions on soil contamination could then converge into a more holistic approach to soil protection.

[77] Although Article 114(5) of the Treaty on the Functioning of the European Union (EUR-Lex - 12012E/TXT - EN - EUR-Lex, 2021) does not allow the Member States to set limits for cadmium in fertilizers independently, the EU may grant exemptions based on new scientific evidence (FitzGerald and Roth, 2015). For this reason we currently have: 12 Member States with Cd limit values ≤ 50 mg Cd/kg P2O5 (CZ, DK, FI, DE, PL, HU, IT, SK, BG, SE, NL, NO), 8 MS with Cd limit values of 60 mg Cd/kg P2O5 (FR, CY, LT, S, RO, SI, GR, LU), 2 MS (Austria and Belgium) with higher Cd limit values.

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[80] Amendments 784-826

[81] EU Farm to Fork Strategy: https://ec.europa.eu/food/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf

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[83] Regarding the control of contamination of agricultural soils and food production, the ANSES recommends a cadmium level of 20mg Cd/kg or less.
AVIS de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif à l'Exposition au cadmium (CAS n°7440-43-9) – Propositions de valeurs toxicologiques de référence (VTR) par ingestion, de valeurs sanitaires repères dans les milieux biologiques (sang, urine, ...) et de niveaux en cadmium dans les matières fertilisantes et supports de culture permettant de maîtriser la pollution des sols agricoles et la contamination des productions végétales. ANSES, 2019

[84] There are more than 30 countries that can supply low-CD rock, including deposits in Australia, China, Egypt, Jordan, Morocco, Russia, Syria, and the United States, Saudi Arabia (Kauwenbergh, 1997). In addition, industry data show that half of global rock production in 2016 may have already met the more stringent EU requirement of 20 mg/kg (5th anniversary of the first proposal for pan-European cadmium limits, 2021).

[85] The cadmium content of phosphate fertilizers can be reduced by using phosphates with low cadmium content, or by decay of phosphate rock or phosphoric acid. The use of phosphate rock with low cadmium content is the dominant market strategy. Decadmization is more expensive and involves a cadmium stream in the decadmium waste, which can cause environmental problems in producing countries (European Commission, 2000).

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