

# FROM SOIL TO CELL: A SYSTEMATIC REVIEW OF THE TROPHIC TRANSFER AND BIOACCUMULATION OF MICROPLASTICS IN THE TERRESTRIAL FOOD WEB

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## Abstract

The accelerated growth of global plastic production has caused Microplastics to become ubiquitous pollutant in land life. Despite the fact that the accumulation of plastic in water bodies has received considerable research, the effects of Microplastics in food web systems fall on land require more research. The systematic review serves as a filling of this lack because it reviews existing information on the movement and collection of Microplastics in terrestrial food webs without neglecting the processes typically considered in aquatic-biased studies. It traces the Microplastics of primary terrestrial sources, including plastic mulch, sewage sludge, wastewater, and atmospheric deposition, to find their way back into biotic elements of the ecosystem. It also describes the movement of the Microplastics by the food chain such as by root plants via fissures as well as by earthworms and other soil invertebrates by ingestion. On a cellular level, it is demonstrated that Microplastics cause oxidative stress, mitochondrion damage, and change the expression of the critical plant genes. It is worth noting that this review questions the usual interpretation of biomagnification: although Microplastics physically decays at higher trophic levels because of forming an efficient excretion. In water the aquatic aspect is manifested through the fact that terrestrial Microplastics may play the role of a hidden carrier, depositing environmental toxins into lipid-rich tissues, accumulating chemicals to preference peculiar to terrestrial food webs. In turn, the intake of Microplastics posing as individual crops and livestock represents a direct and ongoing path of exposure making it to food safety concerns of great significance and emphasizing the need to timely, uniformly measures the risk assessment.

## 1. Introduction

The characteristics like toughness, versatility, and cheap raw material with numerous uses increase the production of plastics. Approximately 368 million tons of plastic were produced worldwide in 2019 (Mitchell, 2026). By 2050, an estimated 12 billion metric tons of plastic waste will be in landfills or the natural environment, a pronounced increase from the 4.9 billion metric tons produced in 2015

(Lamichhane, Acharya et al., 2023). In 2009, microplastics (MPs) were defined as particles smaller than 5 mm (Rogers, 2026). Plastics in the environment can gradually break down into MPs (Yousafzai et al., 2025)

MPs are contaminants of concern due to increased plastic production, improper disposal, and slow biodegradation rates (Andrady, 2011). They have been detected in water (Eriksen et al., 2014; Van Sebille et al., 2015), sediment

(Browne et al., 2011), and various organisms (Cauwenberghe et al., 2015). MPs originate from the breakdown of larger plastic items (secondary MPs) (Andrady, 2011; Browne et al., 2011; Tassone et al., 2025) or from direct release of small plastic particles, such as those in cosmetics (primary MPs) (Browne et al., 2011; Andrady, 2011). Increased population density is correlated with the amplified sources of MPs (Browne et al., 2011), and their dispersion is based on currents, wind, and the density of the particles capable of inter-compartmental transportation of MPs (Bhowmik & Saha,

2026). With their small size, MPs have the ability to influence numerous organisms resulting in obstruction, inflammation, and accumulation in internal organs following translocation (Wright et al., 2013).

Even though the MP pollution is a worldwide problem, its processes and biological outcomes in the landscape ecosystem (terrestrial food web) have received less knowledge. The following review is a summary of the sources, ecotoxicology mechanisms, and cellular impacts of MPs in the food web of the terrestrial environment.

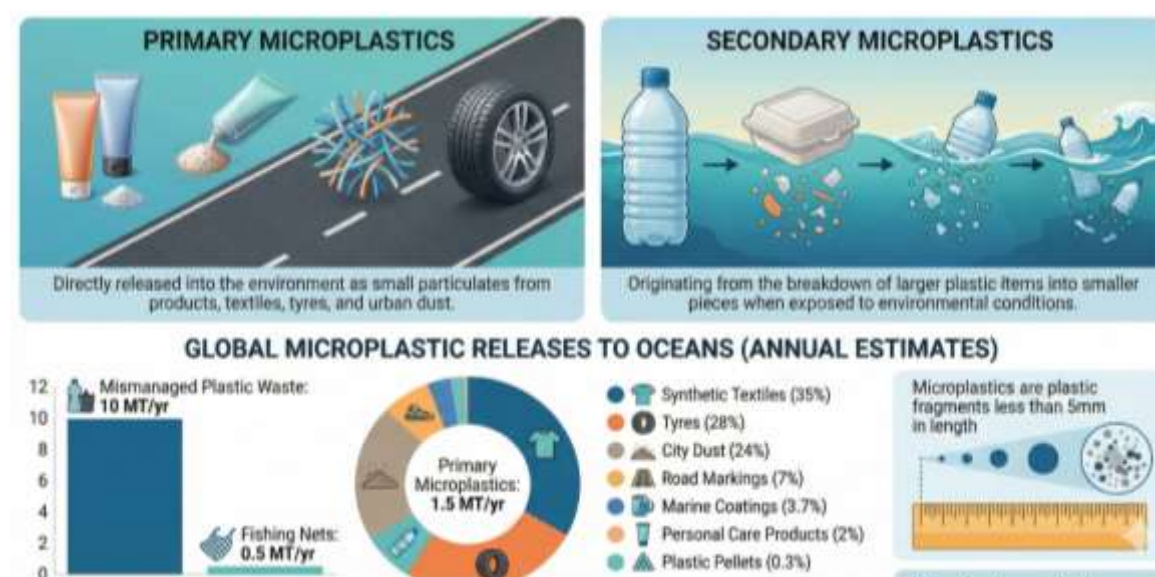


Figure 01: Origins, types and global impact of microplastics

## 2. Methodology

For this review, we located the articles on Google Scholar, Scopus, and ScienceDirect. We have used scientific journals and books with any publication year but we restricted ourselves to articles published in the English language. We limited our search by the following keywords: microplastics and terrestrial, microplastic and soil, microplastic trophic transfer, and bioaccumulation of microplastics.

## 3. Sources and Entry Pathways of Microplastics in Terrestrial Ecosystems

The advancement of modern agricultural system has led to the extensive use of plastic products in cultivation, fertilization, and mulching properties. As these materials degrade within the soil matrix, they contribute a substantial load of MPs which eventually accumulate in crops. MPs

act as ecosystem stressor and alters the biophysical properties of soil in the terrestrial environment (Feng et al., 2022; Guo et al., 2021; Xiao et al., 2022).

### 3.1. Plastic Mulch Films: a Primary Source of Terrestrial Microplastics

In particular, plastic mulch films represent a major source of terrestrial contamination, while widely used in arid regions for moisture retention (Tian, Jinjan et al., 2022). However, their application in tropical ecosystems is of growing concern because high UV radiations and temperature in these regions accelerate the fragmentation of Macroplastics into microplastics and Nanoplastics (NPs) increasing their bioavailability in the tropical food web (Campanale, Massarelli et al., 2020).

Table 01: Possible impact of different MP types on soil microorganisms based on changes in soil enzyme activity and microbial activity.

Polymer Type	Particle Shape	Impact on Soil Enzyme Activity	Impact on Microbial Activity	References
Polyethylene (PE)	Film / Fragments	Decreased Acid phosphatase	Reduced overall microbial biomass; altered bacterial community structure	Fei et al., 2020
Polyvinyl Chloride (PVC)	Fragments	Decreased Fluorescein diacetate (FDA) hydrolase	Significant shifts in microbial diversity and structural composition	Fei et al., 2020
High-Density Polyethylene (HDPE)	Particles / Nanomaterial	Variable (often neutral or slight decrease)	Altered plant-soil microbiome interactions; localized shifts in the rhizosphere.	Judy et al., 2019
Polyester (PES)	Microfibers	Increased $\beta$ -glucosidase (in some soil profiles)	Increased FDA hydrolysis (potentially due to altered soil aeration/porosity)	de Souza Machado et al., 2019
Polyamide (PA)	Microbeads	Variable depending on existing soil chemistry	Stimulated specific bacterial growth while altering overall soil biophysical structure.	de Souza Machado et al., 2019

### 3.2. Sewage Sludge and Biosolids as a Vector

Wastewater Treatment Plants (WWTPs) serve as an important collection point for MPs, which are eventually transferred to the soil through sludge application. Studies showed that sedimentation and primary treatment can trap between 78% and 98% of MPs from influent waters, effectively concentrating them into sludge (Habib, Thiemann et al., 2020). The concentration of these particles in sludge is highly variable, depending on the treatment technology used, with reported values ranging from  $7.91 \text{ MPs/kg}$  to as high as  $240.30 \times 10^3 \text{ MPs/kg}$  (Liu, Qian et al., 2019). Despite their high concentration, the absence of standardized protocols for the quantification of MPs in sludge is a notable complication in terrestrial risk assessment.

### 3.3. Atmospheric Deposition: The Airborne Pathway

Transportation of low-density MPs over long distances, such as  $1,000 \text{ km}$ , is done by atmosphere, the airborne pathway, as it acts as an important carrier. Evidences from studies shows that the smallest particles can cross the national borders to reach distant ecosystems. Transportation through the airborne pathway

can leads to MPs deposition even in the areas of high altitudes, for example, the findings of studies show regions like Tibetan plateau, deposition rates reaching up to  $2.62 \text{ MPs m}^{-2}/\text{day}$ . Through both dry fallout and wet deposition during rain events leads to the transfer of MPs from the atmosphere to land, hence cause the soil contamination where agricultural plastic use is absent. (Edo et al., 2023).

### 3.4. Waste water Irrigation: A Continuous Pathway

Modern wastewater treatment plants (WWTPs) are not designed to eliminate MPs completely, despite having the 97 – 99% high removal efficacy. So, as a result, billions of MPs are being discharged into the environment annually, originating from personal care, textile fibers, and tire wear. (Gies et al., 2018). The farmers of some regions of the world use wastewater for irrigation, because of the nutrients present in it, which leads to contamination of agricultural soils up to  $627,000 \text{ MPs/m}^3$  (He et al., 2018). As a result of consistent use of wastewater for the sake of irrigation leads to long-term accumulation of polymers (like polyethylene and polypropylene) in the soil, making irrigation a

major source of terrestrial contamination (Aydin et al., 2025).



Figure 02: Entry Pathways of Microplastics into Terrestrial Ecosystems

#### 4. Trophic Transfer: From Soil to the Terrestrial Food Web

Trophic transfer is the movement of materials (or contaminants e.g., MPs) from abiotic components of environment (e.g., soil) to biotic components of the environment (food web). Transportation of MPs to soil through airborne pathway and continuous pathway (via irrigation) leads to accumulation of MPs in soil. This is not the end point rather it is the beginning of the entry of MPs into the biotic components.

In terrestrial environments, this transfer mainly occurs through Passive or active uptake by the plant root system and ingestion by invertebrates living in the soil.

Physical characteristics of plastics, including the size, shape, and surface charge are extremely significant in establishing its mobility and bioavailability. As the plastics move to the higher-level consumers, they become a possible cause of cellular toxicity hence a connection to the environmental pollution and the biological health.

##### 4.1. Mechanism of Micro and Nanoplastic Uptake in Plants

As indicated by the latest experimental data, microplastics are not only surface pollutants but can also be actively internalized by key crop species such as wheat (*Triticum aestivum*) and lettuce (*Lactuca sativa*). The data show that sub-

micrometer-scale polystyrene and polymethylmethacrylate particles can penetrate the plant's vascular system, specifically the Stele, by using the crack-entry mechanism at the points of lateral root emergence. After the particles penetrate the root system, they are transported to the above-ground parts of the plant (Ohyama, 2019), a process mainly driven by transpirational pull. These results show that agricultural systems using wastewater irrigation or sewage sludge amendments provide a direct pathway for MPs into the human food chain via edible crops (Li et al., 2020).

##### 4.2. Trophic Transfer in Soil Invertebrates and Higher Organisms

The movement of MPs in the terrestrial food web is greatly aided by soil-dwelling invertebrates, especially earthworms, which act as an important link between the soil and the higher trophic levels. Evidence from tropical home gardens suggests that earthworms actively consume low-density polyethylene residues in the soil, leading to bioconcentration (Huerta Lwanga et al., 2017). Polypropylene microplastics (PP MPs), particularly when mixed with heavy metals ( $Cu^{2+}$  and  $Cr^{6+}$ ), resulted in a substantial increase in the mortality rate of earthworm, resulting in 100% mortality at higher (2x) concentrations. Ingestion behavior was also affected and served as a vector for heavy

metals, which had a detrimental effect on earthworm survival and physiology (Klimasz M., et al., 2025).

Invertebrates such as springtails, earthworm, are adversely affected by MPs due to reduced growth, reproduction, oxidative stress, behavioral responses, intestinal damage, and mortality. MPs may also affect feeding, energy metabolism, and the immune system, causing overall physiological stress.

Studies have shown, the MPs are excreted and absorbed through the livestock based on sizes of ingested pieces. The European Food Safety Authority (2016) determined that most of bigger plastic particles are released through the faeces of the animal but a smaller part of it can

penetrate the gastrointestinal and be embedded in the inner tissues and organs. The release of these particles has been highly reported in different farm animals. In comparative analysis, Wu et al. (2021) determined the concentration of MP 900 particles per kg in pig waste, 677 per kg in chicken waste, and 74 per kg in cattle waste. In some of the other results, there were even greater levels of exposure; Lwanga et al. (2017) reported an average of 129,800 particles per kg in chicken excreta and 31.8 particles per gizzard in a sample of five chickens. The same pollution occurs in sheep, and the researchers of Beriot et al. (2021) detected 977 microplastic particles per kg in the faeces of sheep.

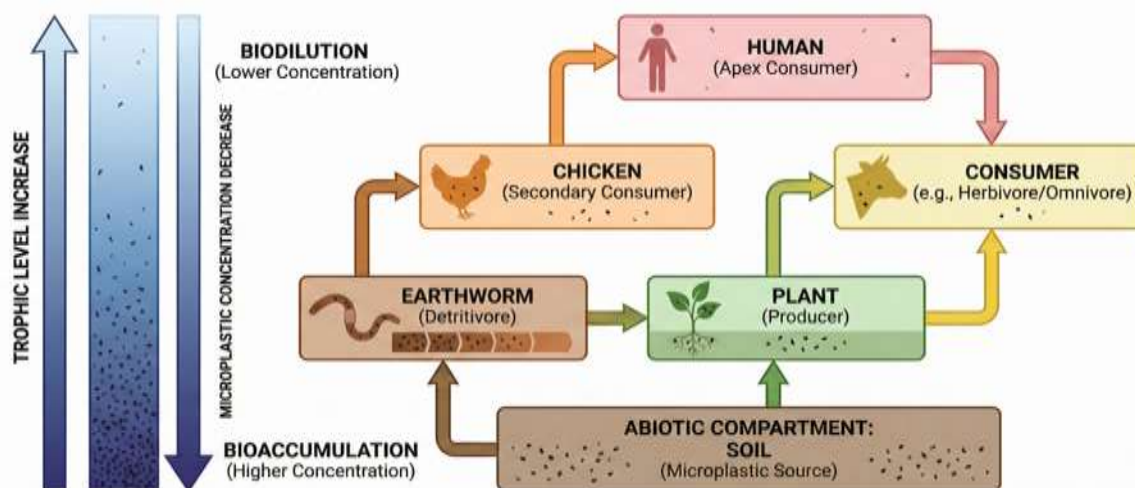


Figure 03: Bioaccumulation & Biodilution Trends Pathways

In addition to digestion and excretion, research confirms that MPs can enter the small intestine and circulatory system and edible parenchyma of the animal. Chen et al. (2023) monitored this gastrointestinal transportation in broilers, and they were able to identify MPs in jejunum, liver, and leg and breast muscles. Van der Veen et al. (2022) report MPs in 100 percent of the 24 cattle and pig blood samples the researchers examined; they also detected MPs in retail beef and pork. This, in turn, is directly the results of contamination of the consumer market, as illustrated by Olmo L. et al. contaminated MP pork and beef.

The research of Mai H. et al. (2023) offers direct field evidence that chicken consume MPs present in contaminated soil and feed, thereby confirming the trophic transfer of MPs in terrestrial ecosystems. MPs are initially taken up

by soil organisms such as earthworms and then transferred to chickens through feeding interactions. It thus confirms the “Soil → Earthworm → Chicken pathway”, thus underlining the MPs flux from the abiotic to the biotic compartment and ultimately imposing risk to human consumers.

Further analysis shows that the larger Macroplastics on the soil surface are ingested by domestic chicken (*Gallus domesticus*), which then undergo physical fragmentation in the digestive system, specifically in the crop and gizzard, to become smaller MPs. This biological process thus directly threatens human health, where chicken organs such as gizzards are a food staple. It is estimated that contaminated gizzards could result in the ingestion of about **840 plastic particles per person per year**, thus underlining the direct relationship between

plastic pollution on the planet and human food safety (Huerta Lwanga et al., 2017).

#### 4.2.5. Trophic Transfer and Bioaccumulation

Studies have found that the concentration of MPs rises cumulatively as they pass along the food chain, from a low concentration in the soil ( $0.87 \pm 1.9$  particles/g) to a higher concentration in earthworm casts ( $129.8 \pm 82.3$  particles/g). This is a concentration ratio of about 150 times from soil to chickens.

#### 4.2.6. Biomagnification

The current literature review offers proof that MPs are transferred from one trophic level to

another through dietary exposure, thus confirming the transfer of MPs through terrestrial and aquatic food webs. Although the transfer of MPs is a universal phenomenon, biomagnification is not a universal process but a function of context. Some experimental and field studies have shown that predators have higher MP concentrations than prey, thus indicating a possible biomagnification process. However, variations in egestion rates, particle size, and physiology among species indicate that the concentration of MPs may not follow a stepwise process from one trophic level to another (S. Gao et al., 2024).

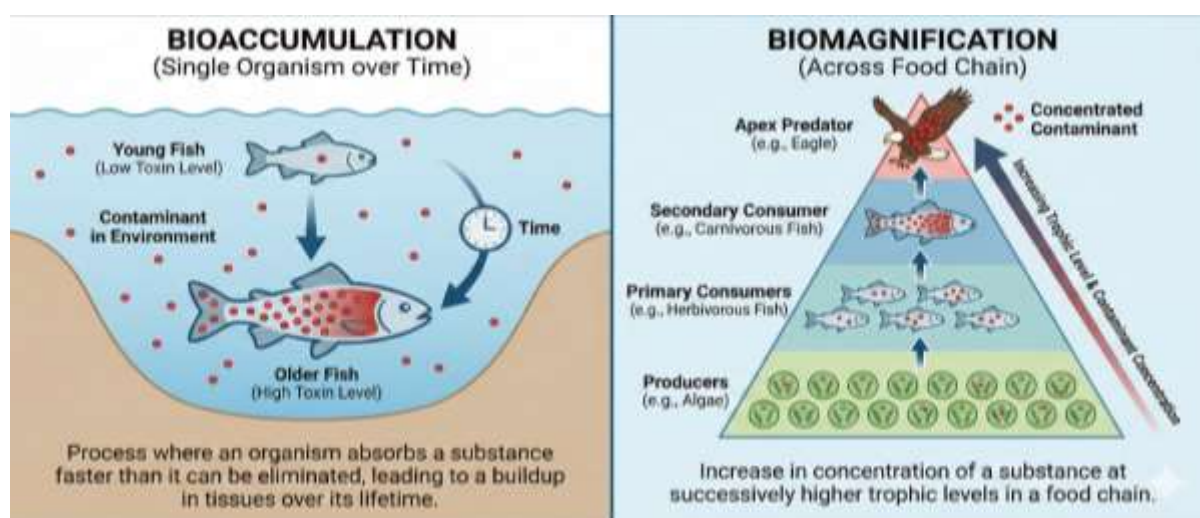


Figure 04: Bioaccumulation and Biomagnification

#### 4.2.7. Biomagnification and Dilution

According to the classic paradigm of ecotoxicology, the pollutants which are hydrophobic (water repellent) in nature can biomagnify through the trophic transfer in a food chain as they have more affinity for lipids and metabolic persistence. Unlike the dissolved compounds like persistent organic pollutants (POPs), e.g., mercury and dichlorodiphenyltrichloroethane (DDT), MPs does not obey classic paradigm in terrestrial ecosystem and act as particulate stressors. The behavior of MPs is not governed by biochemical kinetics rather by the physical laws of sedimentation and egestion. Evidences from different studies shows the bioaccumulation factor (BAF) is more than 1 in lower trophic levels, like earthworms (*Lumbricus terrestris*) and

collembola (*Folsomia candida*), due to their regular soil ingestion.

BAF is typically low in higher trophic levels due to biodilution. Biodilution occurs when the rate of ingestion is lower than the rate of excretion. This happens due to gut clearance efficiency (Huerta Lwanga et al., 2017), and selective retention of certain particles (Rillig, 2012).

### 5. Ecotoxicological Impacts on Terrestrial Life

In terrestrial organisms the presence of MPs and NPs creates a number of disastrous biological reactions, it may be physical damage or any other kind of biochemical imbalance. The terrestrial environment poses a different challenge to the aquatic since the interaction between plastic particles and soil microbes is close since soil plants and invertebrates are found within the soil matrix. The toxicity of these particles is very

much dependent on their size, and concentration and also the leaching of chemicals additives like phthalates and bisphenols on the surrounding tissues. As well, the MPs may serve as vectors of other pollutants such as persistent organic pollutants (POPs). The combined effect

of these synthetic materials contributes to physiological stress, suppressed growth and cellular injury. Ultimately, threatening the stability of terrestrial food webs and broader food security.

**Table 2: Microscopic Bioaccumulation across Terrestrial Species**

Species	Sample Matrix	Microplastic Concentration	References
Cattle	Feces	74 <i>particles/kg</i>	Wu et al., 2021
	Blood	0.07 – 33.00 <i>mg/kg</i>	Van der Veen et al., 2022
Pig	Feces	900 <i>particles/kg</i>	Wu et al., 2021
	Blood	0.07 – 33.00 <i>mg/kg</i>	Van der Veen et al., 2022
Sheep	Feces	997 <i>particles/kg</i>	Beriot et al., 2021
Chicken	Excreta	667 <i>particles/kg</i> to 129,800 <i>particles/kg</i>	Wu et al., 2021; Lwanga et al., 2017
	Gizzard	1.8 <i>particles/gizzard</i>	Lwanga et al., 2017
Broiler	Tissues (Jejunum, Liver, Muscle)	2.2 – 1751.4 <i>mg/kg</i>	Chen et al., 2023

**Table 3: Estimated Human Exposure via the Terrestrial Food Web**

Dietary Source	Contamination Level	Estimated Human Intake	References
Fruits (General)	223,000 <i>particles/g</i> (median)	Not specified	Conti et al., 2020
Vegetables (General)	97,800 <i>particles/g</i> (median)	Not specified	Conti et al., 2020
Apples	Highest among fruits	$4.62 \times 10^5$ <i>particles/day</i> (adults); $1.41 \times 10^6$ <i>particles/day</i> (children)	Conti et al., 2020
Chicken Gizzard	31.8 <i>particles/gizzard</i>	840 <i>particles/year</i> (based on 15 chickens/year)	Lwanga et al., 2017

### 5.1. Phytotoxicity and Physiological Stress in Crops

Due to the vast and consistent use of plastic mulch in agriculture leads to the contamination of soil, the resulting consequences are yet to be explored. Based on research conducted on wheat (*Triticum aestivum*) the result shows that almost 1% concentration of plastic residues found in the soil. These plastic residues affect the growth phases of the plant at a large level (Qi et al., 2018). These residues affect badly in both manners; by effecting above ground biomass growth and below ground root development.

It is also noted that the type of polymer used also effect the level of phototoxicity. It has been observed that starch-based biodegradable plastic films cause more severe negative effects on wheat

effects on wheat growth than traditional low-density polyethylene (LDPE) films. This is a major concern: biodegradable plastics, although considered eco-friendly, tend to break down faster into micro-scale particles, thereby increasing their interaction with plant tissues and soil health. Moreover, although the presence of soil organisms such as earthworms may provide some physiological relief to the plants by boosting soil properties, they are unable to counteract the growth-inhibiting effects of high plastic concentrations (Qi et al., 2018).

## 6. Cellular Internalization and Toxicity

### 6.1. Translocation Mechanisms

After entering the root system, MPs move into the vascular bundle through the apoplastic pathway and then are transported to the above-ground organs through xylem-based transpiration flow (Lie et al., 2020). On the other hand, MPs that are captured by foliar surfaces, can be transported downward toward the roots through the phloem. These internal transport processes are mainly dependent on passive forces, namely water potential gradients and pressure gradients in the vascular system (Lie et al., 2020). At the cellular level, aquaporins act as a major entry point for NPs to overcome apoplastic barriers and enter the cytosol. Studies have shown that a decrease in the transport activity of aquaporins results in a corresponding decrease in the uptake of these particles at the cellular level (Lie et al., 2020).

### 6.2. Cellular Uptake

In root-mediated uptake, size-based mechanisms and the physical entry points regulates the uptake of MPs within the plant systems. The larger MP particles ranged from  $0.2 - 200 \mu\text{m}$  enter via “crack-entry” mechanism by creating mechanical cracks (Lie et al., 2020). The cell wall act as the primary security filter at the cellular level. Endocytosis of NPs, smaller than  $200 \text{ nm}$ , leads to transfer of NPs to plasma membrane through engulfing by vesicles. Other than the root-mediated uptake, the foliar stomata, which open to  $3 - 10 \mu\text{m}$  widths, also involve in the uptake of MPs. The uptake of MPs is highly dependent on the zeta potential and the surface charge of the particle (Shan et al., 2010), which ultimately regulates the initial adhesion of plastic to plant surface. The hydrophobic nature of polymers like (polyethylene and propylene) is likely to determine the systemic translocation throughout the plant.

### 6.3. Cytotoxicity and Molecular Effects

MPs and NPs enter inside the cell, they start a cascade of several molecular level damages such as oxidative stress, inflammatory responses, changes in gene expression and disruption of organelles.

#### 6.3.1. Oxidative Stress

Oxidative stress is one of the main mechanisms of MP and NP phytotoxicity (Yuan et al., 2023), which occurs when the interaction between particles and cellular organelles, such as mitochondria and chloroplast, leads to the overproduction of reactive oxygen species (ROS) (Sun et al., 2020; Mansoor et al., 2023). To overcome this, plants possessed a complex antioxidant system that is encompassed in enzymes like superoxide dismutase (SOD), catalase (CAT), and peroxidase (POD). This response is extremely size-dependent, and smaller NPs ( $< 100 \text{ nm}$ ) tend to induce a more pronounced change of enzymatic activities because they are more bioavailable and have nanoenzyme effects in comparison with larger particles. In case of their overload, ROS-mediated lipid peroxidation will be induced with apparent malondialdehyde (MDA) concentrations and damaged membranes of the cells (Lie et al., 2020). So, to further overcome this stress, the plants also strive to reduce this stress through the up-regulation of the biosynthesis of non-enzymatic antioxidants like flavonoids and glutathione, but the excessive loss of these antioxidants during ROS scavenging process can eventually lead to the depletion of antioxidants, hence leading to system metabolic failure.

#### 6.3.2. Inflammatory Responses and Gene Expression Changes

Transcriptomics analysis makes it possible to have a molecular-level perspective on the manner in which MPs disrupt the physiology of plants. Based on RNA-sequence methods, key differentially expressed genes (DEGs) which respond to stress caused by MP are detected in several species (*Arabidopsis thaliana*, rice, wheat) (Sun et al., 2020). Of significance is the expression of antioxidant defense system and cellular detoxification genes due to which the plant strives to capture and lock the internalized particles.

On the other hand, the widespread down regulation of genes associated with photosynthesis and cell growth (such as *cdc2*) is directly linked to reduced biomass and stunted crop growth (Shoala, 2012). In addition, changes in the signaling pathways of plant hormones, particularly auxin and abscisic acid,

affect root growth and nutrient assimilation. These transcriptomic changes are necessary for understanding bioaccumulation because they indicate how MPs affect plant fitness and quality, which, in turn, determines the efficiency of MP trophic transfer to higher-level organisms in the terrestrial food chain.

### 6.3.3. Disruption of organelles

In addition to the general oxidative stress, it was found that the size of the particles determines the particular organelle-mediated pathways of death. For example, 20 nm synthetic polystyrene nanoparticles (PS NPs), and not larger beads, are quickly taken up by

macrophages and accumulated in the mitochondria, leading to a breakdown in the mitochondrial integrity and an increase in mitochondrial reactive oxygen species (mtROS), which selectively triggers necroptosis, programmed cell death (Liu et al., 2015). The relevance of this organelle dysfunction has further implications in systemic health, as it was shown in murine models that this macrophage necroptosis led to acute liver damage due to inflammatory interactions with hepatocytes. This was particularly abrogated by the use of necroptosis inhibitors, therefore confirming the role of mitochondrial dysfunction in organ pathology.

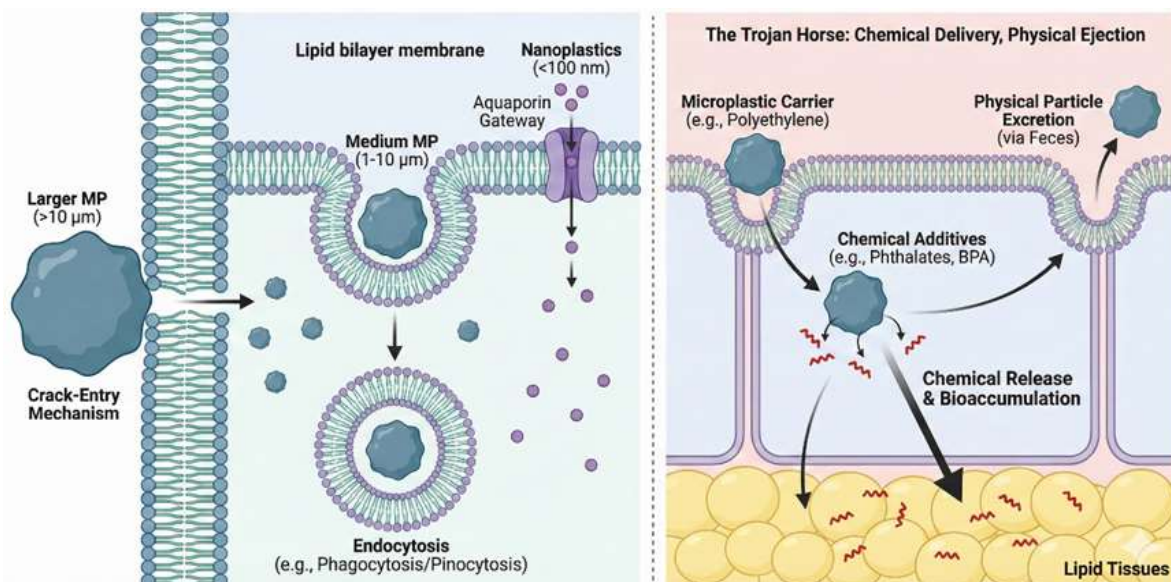


Figure 05: Microplastic Cellular Interactions

## 7. Implications for the Human Food Chain

### 7.1. Direct Ingestion via Edible Produce

However, new evidence has emerged, shifting the emphasis from surface contamination to internal uptake of MPs in the edible parts of terrestrial plants. Quantitative analysis using SEM-EDX reveals that MPs smaller than 10 μm are universally distributed in vegetables and fruits, with fruits having higher median values (223,000 particles/g) than vegetables (97,800 particles/g). In particular, apples were found to be the most contaminated fruit, while carrots had the highest MP load among vegetables and the smallest average particle size (1.51 μm).

These results show that MP uptake is likely to follow the translocation pattern of carbon

nanomaterials, in which sub-micrometer particles are absorbed through the root system and transported throughout the plant's vascular system. As such, the estimated daily intake (EDI) of the human body is substantial; for example, the consumption of apples alone would lead to an EDI of  $4.62 \times 10^5$  particles per day for adults and as high as  $1.41 \times 10^6$  particles per day for children. The high EDI of MPs through dietary exposure indicates an urgent need for toxicological studies to assess the long-term effects of internalized MPs on the human gastrointestinal tract and systemic health (Conti, Ferrante et al., 2022).

### 7.1.1. Direct Ingestion via Animal-Derived Products

Direct human consumption of MPs also heavily occurs through the consumption of contaminated livestock organs. In areas where chicken gizzards are a food source, it is estimated that an individual could consume as many as 840 plastic pieces per year, assuming a consumption rate of 15 chickens per year. This is especially true in areas where domestic waste is not properly managed and livestock feed directly on contaminated soil surfaces. Although these plastics do not contain macro-debris, their biological breakdown in the avian gut leaves an increased chance that smaller MPs will make it into the human gastrointestinal tract and trigger localized inflammation or oxidative stress (Huerta Lwanga, Mendoza Vega et al., 2017).

### 7.2. Indirect Exposure

Beyond the direct diet, humans face exposure through the atmospheric fallout. Textiles can contribute to MPs in the atmosphere, and every item of clothing has the potential to contribute to **1,900 fibers** per wash cycle (Browne et al., 2011). Most probably, the same fibers are also released into the atmosphere. This assumption is supported by guidelines for microplastic sampling, which warn of the risk of airborne contamination (Browne et al., 2011). Some researchers have experienced contamination of their sampling and/or their working environment through employing the use of blanks or open petri dishes which can be related to airborne MPs released from clothing. Subsequent studies have confirmed the presence of MPs in the atmospheric fallout of a city, which supports the hypothesis of airborne contamination.

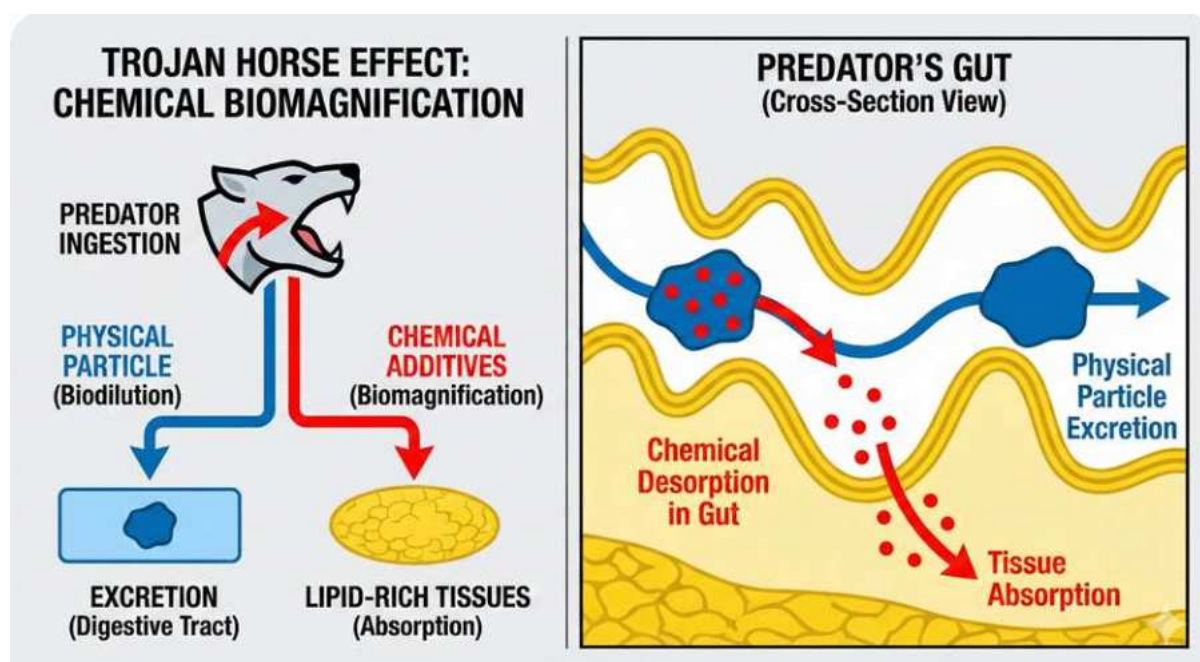


Figure 06: Trojan Horse Effect

### 8. Conclusion

The terrestrial food web does indeed suffer a quantitative reduction in physical plastic particles at higher trophic levels, a phenomenon known as biodilution, it also suffers a hidden qualitative process, “chemical biomagnification”. MPs function as “Trojan Horses”, as highly mobile vectors of toxic chemical additives such as phthalates and bisphenol A (BPA), as well as other adsorbed

environmental toxins. Whereas the predator’s digestive peristalsis might successfully expel the physical plastic particle, the chemical components desorb during passage and smoothly integrate into the lipid-rich tissues. Thus, solely depending on conventional particle counting would dangerously obscure this combined Trojan Horse effect, in which physical biodilution masks extreme chemical biomagnification. The increasing use of heavy

metals contributes to rising toxicity. Humans are now exposed to both heavy metals and MPs. However, the combined effects of MPs and heavy metals in terrestrial food webs remain uninvestigated.

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