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Plastic Footprint Network

Plastic Footprint Guidelines

Module on plastic leakage from agriculture

Version 1 – March 2026

Convened by EA – Earth Action · www.plasticfootprint.earth

Introduction to the Plastic Footprint Network

Leading organizations have united within the Plastic Footprint Network to chart a new, more effective **path toward plastic pollution** mitigation.

The network's first priority was **unifying the framework** for measuring plastic leakage into a **single**, **science-based methodology** for organizations to accurately assess the environmental impact of their plastic use. Over **100 professionals** from **40+ organizations** collaborated to establish the **methodology**, consisting of **11 modules**, all optimized for usability and delivery of **actionable results**.

Objectives

Unifying the methodologies and perspectives of leading scientists, experts, and global practitioners, PFN enables organizations to understand the full impact, or footprint, from the use of plastic in their companies, products, and services.

1. Update and unify plastic footprinting methodologies
2. Ensure the methodology is used consistently by practitioners
3. Disseminate and scale the use of plastic footprinting
4. Explore how mitigation actions can be effectively measured and prioritized

What will you find in this module?

The goal of this module is to provide a unified approach to estimate the contribution of plastic from agriculture activities in the context of a plastic footprint. To achieve this, we will address the following questions:

1. What are the essential components of the methodology proposed in this module for estimating the contribution of plastic from agriculture activities in a plastic footprint?

2. How does this module integrate and build upon existing approaches and literature to ensure a thorough and up-to-date assessment of the plastic footprint?

3. What secondary data sources are essential for conducting accurate estimations and how can these inputs be integrated into the overall assessment process?

At the end of this module, the users should know how to include plastic leakages from agriculture activities in their plastic footprint assessment.

Where does this module fit in the PFN landscape?

Guidance

Strategic | Cross-cutting or specific issue

- Introduction to plastic footprinting
- Scopes and boundaries
  Alignment with environmental reporting standards
- Data governance
- Plastic Pollution Mitigation Action Framework (PAF)

Technical

- Technical introduction to plastic leakage
- Glossary

Inventory: Macroplastics

- Packaging
- Textile
- Fishing gears
- Leakage from export
- Release rates
- Long Life Items
- Paint
- Construction
- Automotive

Inventory: Microplastics

- Micro Tire and Roar Wear particles (TRWP)
- Textile Microfibers
- Micro packaging
- Micro paint
- Micro agriculture (Current module)
- Micro pellets

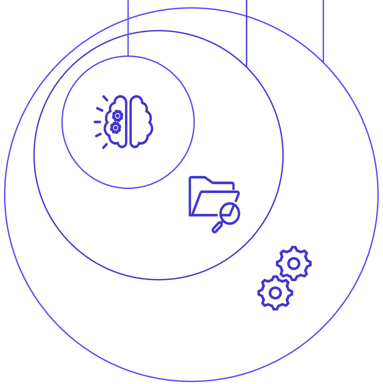
Impact

- Impact of microplastic leakage
- Impact valuation

Sectorial guidance

- Agriculture
- Medical
- Apparel

Structure of each technical module



1 Methodological choice

High level overview and different methodologies available at the moment, which one(s) to use and when.

Target audience: busy reader, scientific journalist

2 System map and calculation routes

- The different elements to take into account during a plastic footprint.
- How these elements interact.
- The calculation routes to follow.

Target audience: scientist, experts

3 Key data & background assumptions

The secondary data needed to perform the assessment and the main assumptions for the modeling.

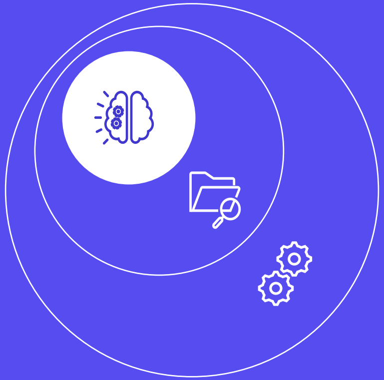
Target audience: scientist aiming at performing a plastic footprint.

Reading keys: Main take away Supporting information Key warning

Part. 1

Methodological choice

The different methodological approaches that can be taken, which one(s) to use and when.



Context

The challenge of soil pollution with plastics from agriculture

Agricultural soils are among the most plastic-contaminated ecosystems worldwide [1,2]. Plastics are introduced through **mulch films, greenhouses, irrigation pipes, fertilizers, and sewage sludge [2]**. Estimates suggest that **agricultural soils receive 4 to 23 times more plastic residues than the oceans** each year [1].

The lack of **standardized methods** to quantify plastic release in soil hampers reliable assessment and comparison across practices [3]. Fragmentation, degradation, and accumulation processes depend heavily on **local conditions and polymer types**, making harmonization essential [3]. Micro- and nanoplastics can alter **soil structure, water retention, and microbial activity**, ultimately affecting **crop productivity and food safety** [3].

For companies, integrating this issue into their **plastic footprint** is
critical to:

- Identify hidden sources of plastic leakage from agricultural supply chains
- Anticipate future **regulatory restrictions and reporting requirements**
- Support **sustainable land management and responsible sourcing** initiatives

Fig 1. Plastic pathways to agricultural soils grouped into plastics from agricultural practices, urban influence, and hydrometeorological drivers
Source: [4]

Key methodological questions for agriculture

In plastic footprint assessments, leakage from agriculture activities may occur from a diversity of sources . This raises two critical methodological questions:

A

Question 1

What are the main pathways and sources contributing to plastic pollution in agricultural soils?

B

Question 2

How can these plastic leakage be characterized in terms of quantity but also polymer type, particle size, and morphology?

An overview of leakage from agriculture

Plastic leakage from agriculture into ocean and land

Leakage from plasticulture

e.g. plastic particle from mulch remaining on soil after harvest

Leakage from agricultural inputs

e.g. compost contaminated with plastic particles

Transfer from environment into agricultural soils

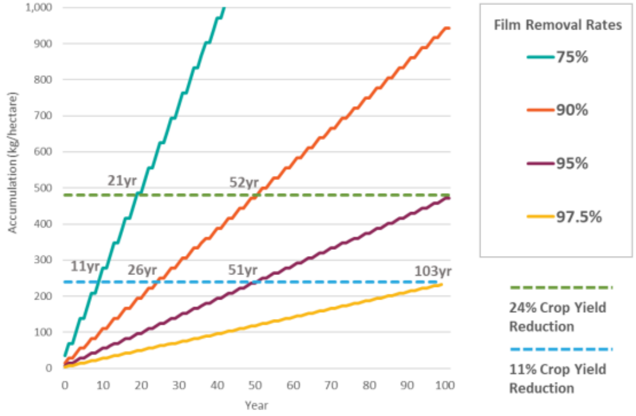
e.g. microplastics carried by rainwater

Leakage from agricultural inputs packaging and Tire-derived particles were excluded as already addressed in other PFN module. Adaptations may be required to fully address the specific context of agricultural activities

How big is agriculture leakage

Source : [5] European Commission (2021) Conventional and Biodegradable Plastics in Agriculture.
Report for DG Environment of the European Commission

Figure E- 2: Conventional Plastic Mulch Film Accumulation Model



Source: Eunomia modelled calculations

- Around 63% of agri-plastic non-packaging waste generated in the EU was reported as collected in 2019 by APE Europe. The fate of the remaining 37% of agri-plastics is not known – as by definition this is not recorded – but the agri-plastics may be stored, burnt, buried, or collected with another waste stream.
- If 5-25% mulch film remaining is averaged across the EU, the annual use of 83,000 tonnes of mulch film would result in 4,750 -20,750 tonnes of conventional plastic remaining on agricultural land every year.

Recommended methodological approach

Primary data needed:

- Type of crop, yield/cropping area, use of plasticulture component, quantity of agricultural input and types

Primary data good-to-have:

- Mass of plasticulture component, component lifespan, crop length

Secondary data needed:

- Share of plasticulture component collected, released rate from the non collected share of component, plastic particle content of agricultural inputs

The mass and lifespan of plasticulture components should ideally be primary data and component-specific, but in case this is missing, average mass and lifespan can be used.

Released rate from the non collected share of component may depends on farmer practices (reuse, burning) and fragmentation & degradation mechanisms

The type and of plastic particle may affect release (i.e. the share of emissions that ultimately reaches environmental compartments) due to variable degradation mechanisms (as well as climate and soil conditions)

Steps:

1. Collect primary data: type of agricultural commodity, yields/cropping area, use of plasticulture component, quantity of agricultural input and types
2. For each plasticulture component/agricultural input
    1. Compute mass : quantity of plastics used/applied and allocated to the crop
    2. Compute loss: Remove managed plastics (plasticulture only)
3. Compute release: Multiply the lost mass with the release rates

$$\text{Leak}_{soil} = \sum_{\text{crop/crountry}} \sum_{Source} Mass\ x\ Loss\ (for\ plasticulture\ only)\ x\ Release$$

With sources being plasticulture components, agricultural inputs and environment

Generally speaking, always prefer primary data if available but plasticulture component and inputs rates could be defined per crop/country

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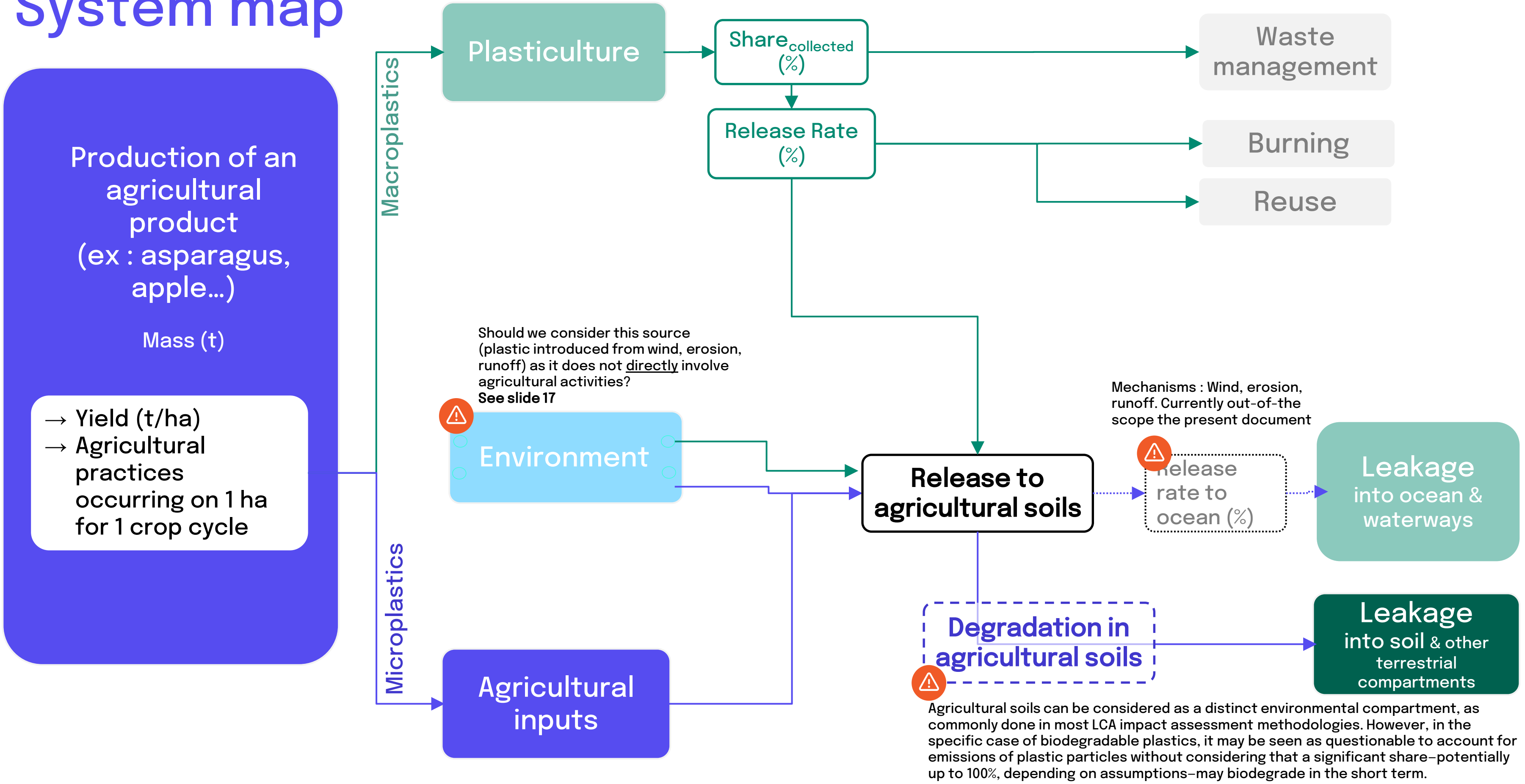
Part. 2

System map & calculation routes

The different elements to take into account during a plastic footprint. How these elements interact? Which calculation routes to follow?

System map


Production of an agricultural product (ex : asparagus, apple…)
Mass (t)
→ Yield (t/ha)
→ Agricultural practices occurring on 1 ha for 1 crop cycle
Macroplastics
Microplastics
Plasticulture
Share$_{collected}$ (%)
Release Rate (%)
Waste management
Burning
Reuse
Should we consider this source (plastic introduced from wind, erosion, runoff) as it does not directly involve agricultural activities?
See slide 17
Environment
Agricultural inputs
Release to agricultural soils
Mechanisms : Wind, erosion, runoff. Currently out-of-the scope the present document
elease rate to ocean (%)
Leakage into ocean & waterways
Degradation in agricultural soils
Leakage into soil & other terrestrial compartments
Agricultural soils can be considered as a distinct environmental compartment, as commonly done in most LCA impact assessment methodologies. However, in the specific case of biodegradable plastics, it may be seen as questionable to account for emissions of plastic particles without considering that a significant share–potentially up to 100%, depending on assumptions–may biodegrade in the short term.

Calculation routes for leakage from plasticulture

$$\boldsymbol{Leak}_{soil}(kg) = \sum_{crop}\sum_{componant} \underbrace{\boldsymbol{M}_{component}\,(kg) \times \frac{\text{Crop duration (month)}}{\text{Component life span (month)}}}_{\text{Mass}} \times \underbrace{\left(100 - \boldsymbol{Share}_{collected}(\%)\right)}_{\text{Loss}} * \underbrace{\boldsymbol{RR}_{componant}(\%)}_{\text{Release}}$$

Symbol	Description	Unit	Value	Reference	Additional comments
$M_{component}$	Quantity of plastic used for 1 ha for the specific component	*kg*	From primary data		Tables providing mass per component (kg/ha) could be suggested for each type of component or per crop/country.
Component lifespan		months	From primary data		Tables providing lifespan could be suggested for each type of component (+crop/country)
Crop duration	Length of the crop cycle from the harvest of the previous crop to the harvest of the current crop	months	From primary data		Table providing crop duration for categories of crop could be suggested
$Share_{collected}$	Collection rate of the component	%	Primary or secondary data	[6]	Data to be found for other countries than France
$RR_{component}$	Difference between the non-collected share of the component and the actual share of the component released in soils	%	Primary or secondary data		RR=100% means that none of the plastic is reused or burned. Depends on farmer practices (burning, reuse) , fragmentation and degradation processes. Management scenarios could be defined per crop/country
$Leak_{soil}$	Quantity released to agricultural soil and other terrestrial compartments per ha of crop	kg	Calculated		

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Example for 1 ha of organic tomato under greenhouse

Tomato, organic, greenhouse production, national average, at greenhouse {FR}

Symbol	Description	Unit	Value	Reference
$M_{component}$	Quantity of plastic used for 1 ha for the specific component	kg	14 239 kg	AGRIBALYSE
Component lifespan		months	84 (7 years)	AGRIBALYSE
Crop duration	Length of the crop cycle from the harvest of the previous crop to the harvest of the current crop	months	5	AGRIBALYSE
$Share_{collected}$	Collection rate of the component	%	84	[6]
$RR_{component}$	Difference between the non-collected share of the component and the actual share of the component released in soils	%	100% 10%	Worst case scenario Best case scenario
$Leak_{soil}$	**Quantity released to agricultural soil and other terrestrial compartments per ha of crop**	**kg**	**135** **13**	**Worst case scenario** **Best case scenario**

Calculation routes for leakage from agricultural inputs

$$\boldsymbol{Leak}_{soil}(kg) = \underbrace{\sum_{crop}\sum_{inputs} \boldsymbol{M}_{inputs}(kg) \times \boldsymbol{Allocation}_{crop}}_{\text{Mass}}\ \underbrace{(\%) \times \boldsymbol{Share}_{plastic\ particle}(\%)}_{\text{Loss \& Release}}$$

Symbol	Description	Unit	Value	Reference	Additional comments
M_{input}	Quantity of inputs used for 1 ha for the specific component	kg	From primary data		
$Allocation_{crop}$	Share of the input benefit allocated to the crop	%	<100% for slow-release fertilizers	AGRIBALYSE?	
$Share_{plastic\ particle}$	Plastic particle content of each inputs	%	Secondary data	[7-9]	Could be specified by type of plastic and size of particle*
$Leak_{soil}$	Quantity released to agricultural soil and other terrestrial compartments per ha of crop	kg	Calculated		

* An analysis of plastic particles from the diverse sources is available in slide 23

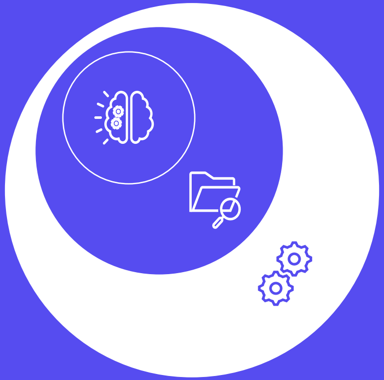
Calculation routes for transfer from environment

- Environmental transfers of plastics to agricultural soils (e.g. atmospheric deposition, contaminated rainwater) remain highly uncertain and currently lack standardized quantification methods [1,3].
- These diffuse inputs are not directly driven by agricultural practices and are therefore difficult to attribute to a specific system or include in a plastic footprint, which typically focuses on controllable and traceable sources [2].
- However, they still contribute to overall soil contamination and should be acknowledged, while clearly distinguished from practice-related emissions.

Part. 3

Data

The secondary data needed to perform the assessment.



Mass and lifespan of plasticulture component

Potential sources : Ecoinvent, AGRIBALYSE

Component	Mass (kg/ha)	Lifespan (months)	Source
Wrapping films			
Silage cover films			
Low tunnel films			
Greenhouse films			
Mulch films			
Twines			
Round bale nets			
Hail protection nets			
Irrigation hoses			

Example from AGRIBALYSE	Mass (kg/ha)	Unit
1 Greenhouse (Lifespan = 10 years)	2144	kg
1 mulch film (Lifespan = 2 years)	290	kg

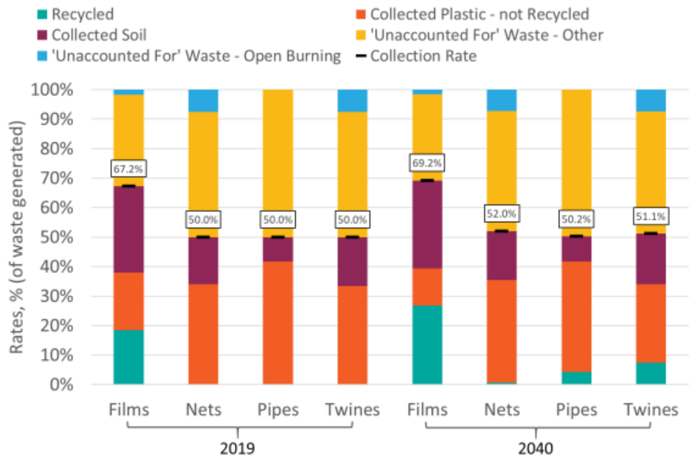
Share of each component collected (1/2)

Source : [6] A.D.I.VALOR. *Rapport d'activité 2023 – 2023: mobilisation et performance*. Éditorial par Christophe Grison, président, et Ronan Vanot, directeur général. Consulted on 25 August and available on https://www.adivalor.fr/docs/sharedoc/157/rapport-activite-adivalor-2023-web-3.pdf

<table>
<tr><th>Component</th><th>Share_{collected}</th></tr>
<tr><td>Wrapping films</td><td rowspan="2">85%</td></tr>
<tr><td>Silage cover films</td></tr>
<tr><td>Low tunnel films</td><td rowspan="2">84%</td></tr>
<tr><td>Greenhouse films</td></tr>
<tr><td>Mulch films</td><td>90%</td></tr>
<tr><td>Twines</td><td rowspan="2">53%</td></tr>
<tr><td>Round bale nets</td></tr>
<tr><td>Hail protection nets</td><td>49%</td></tr>
<tr><td>Irrigation hoses</td><td>86%</td></tr>
</table>

Source : [5] Conventional and Biodegradable Plastics in Agriculture

Figure E- 3: Final Destinations of Agri-Plastic Waste in the EU28, Thousand Tonnes (2019, 2040)



Share of each component collected (2/2)

First attempt to obtain data at world scale using IA

Country/Region	Agricultural plastic placed on market (t)	Collection rate (%)	Recycling rate (of collected, %)	Energy recovery / incineration (%)	Landfill / mismanaged (%)	Main applications	Primary source / notes
European Union (27)	707 800	63,6	50	20	16,4*	Films, nets, irrigation pipes, twines	APE Europe 2019; EC 2021
France	150 000	71	63,9	7,1	29	Films (silage, mulch), irrigation, nets	Adivalor 2024
Spain	182 000	79	60	10	11*	Greenhouse films, mulch films, nets	FAO 2019; EC 2021
Germany	120 000	37	40	30	23*	Silage films, pipes, bale nets	EC 2021 (ERDE data)
Italy	95 000	55	45	25	20*	Mulch films, greenhouse films	EC 2021 (national report)
Norway	8 800	85	70	10	5*	Silage films	APE Europe (2019 data)
United Kingdom	70 000	50	50	20	20*	Silage and mulch films	DEFRA estimates; WRAP 2020
Global (all regions)	12 500 000	15	20	25	60*	All agricultural plastics	FAO 2019; OECD 2022

*The report [5] indicates that approximately **37% of agricultural plastics remain uncollected ("unknown fate") in the EU.**

Share of plastic particle for a range of agricultural inputs

Source for Organic residual product (ORP) : [7] ADEME - Agence de la transition écologique; Mortas, N.; Thévenin, N.; Ehrhardt, F.; Ruidavets, L.; Rabat, C.; Kedzierski, M.; Cirederf, D.; Yeuch, V.; Durand, G.; Caurant, A.; Goulitquer, S.; Even, A.; Maisonnat, S.; Cuny-Yesbergenova, Z. (2023). *Microplastiques présents dans les produits résiduaires organiques en France métropolitaine*. ADEME

Organic residual products		Particle plastic (g/kg dry ORP) Min	Max
Sewage sludge	Sewage sludge	0.1	0.18
Composts	Compost with DCT (separate collection)	0.19	0.50
	MBT compost (mechanical-biological treatment)	2.40	6.30
	Compost without DCT	0.05	0.09
	Compost from solid residues of municipal waste	10.84	–
	Compost from biowaste and green waste	0.5174	–
	Compost from sewage sludge and green waste	0.2104	–
Digestates	Agricultural digestates	0.03	0.06
	Sewage sludge digestates	0.17	0.34
	Digestates from DCT or GP (separate collection or mixed waste)	0.61	1.49
Agricultural effluents	Livestock effluents	0.04	0.46
Other ORP	Shredded materials	0.06	0.15

Other ag. inputs	$\text{Share}_{\text{plastic particle}}$	Source
Coated fertilizer	10%	[8]
Coated seed	0,67%	[9]

[8] Naoya Katsumi, Takasei Kusube, Seiya Nagao, Hiroshi Okochi. 2021. Accumulation of microcapsules derived from coated fertilizer in paddy fields, Chemosphere, Volume 267, 129185
[9] Cesare Accinelli, Hamed K. Abbas, W. Thomas Shier, Alberto Vicari, Nathan S. Little, Maria Rosaria Aloise, Sara Giacomini, 2019. Degradation of microplastic seed film-coating fragments in soil, Chemosphere, Volume 226, Pages 645-650

Share of coated fertilizer and coated seed could be defined at crop/country scale

Data for irrigation water is missing. May depend of water origine (country, groundwater, surface water)

Identification and characterization of plastic pollution flows

Plastic flows	Type of polymer	Particle shape	Influencing parameters	Sources
Mulch films	PEBD	Films	**Amount of plastic used (mass)** **Collection rate** **Component lifespan**	[8,6,9]
Greenhouse films	PEBD, PVC, EVA	Films		
Irrigation hoses	PEBD	Films		
Hail protection nets	PEHD	Fibres		
Round bale nets	PEHD	Fibres		
Twines	PP	Fibres		
Coated fertilizer	PE, PU, alkyd resin	Microcapsules	Applied nitrogen mass / crop, % by mass of nitrogen contained in the fertilizer, amount of plastic contained in the fertilizer	[10,11,12]
Coated seeds	PVOH + PVACs, methyl cellulose, CMC, starch, gum Arabic	Microcapsules	Mass of coated seeds / culture, quantity of plastic contained in the seeds	[13,14]
Packaging for ag. inputs	PE, PP	Fragments, Films	Masse des emballages, % collected	[15]
Sewage sludges	PET, PES, PP, PE, PA	Fibres	• Concentration of plastic in fertilizer • Quantity of fertilizer applied (mass) / year	[16]
Agricultural effluents	PE, PP, PES, Rayon	Fibres, Fragments		
Composts	PE, PS, PES, PET	Fragments, Films, Fibres		
Digestates	PE, PS, PVC, PP	Fragments, Fibres, Spheres		
Other ORP	PE, PP mainly	Fibres, Fragments		
Tire-derived particles	Natural and synthetical rubber	Cigar-shaped coarse particles	Type of vehicle, type of road, distance traveled	[17]
Irrigation	PAN, PP, PET, PE	Fibres	Concentration of plastic in the water provided, volume of water provided	[18]
Atmospheric deposition	PE, PP PS, PET, PVC, Rayon	Fibres	Location, precipitation rate	[19, 20, 21, 22]
Surface runoff	PP, PE	Fragments, Fibres, Films	Location, precipitation rate	[23, 124]
Wind	PP, PE	Fragments, Fibres, Films	Location, precipitation rate	[25]

Legend

- Films
- Fibres
- Microcapsules
- Fragments
- Spheres

The use of quantitative data from scientific literature is limited to the lack of standardized method for quantifying plastics particles in matrixes (soils, ORP).
Most authors express quantities in number of particles (and not in mass) and extraction method differs across studies.

Conclusion and next steps

Global methodological approach

- Discuss the system perimeter and the reference flow ($Leak_{soil}$ for 1 kg of product or for 1ha of crop)
- Discuss the level of granularity :
  - primary data / secondary data
  - Crop/country scenario
- Discuss the need to adapt transport and packaging models to be used within the agriculture module
- Discuss the relevancy of integrating plastics particles fragmentation in the release rate

Calculation routes

- Discuss the reliability of using the collected share for plasticulture component
- Identify data / approach to estimate the Release Rate in a robust way :
  - The burning/reuse rate according to farmer's practices at country scale and if possible, for each plasticulture component
  - The fragmentation of each component
- Discuss how to integrate a release rate to ocean and waterways

Secondary data

- Extract from LCA databases mass and lifespan of plasticulture component
- Obtain a value at world scale for the $\mathbf{Share}_{collected}$ for each plasticulture component
- Use the scientific literature to increase the reliability of plastic particle composition of ORP (currently based on ADEME data). At some point discuss the need for a model to estimate this quantity based on ORP composition and processing
- Gather data for plastic particle concentration in irrigation water at country/water type scale

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PFN

Our mission is to continuously advance Plastic Footprint Methodology, ensuring it remains at the forefront of sustainable practices and promoting its widespread adoption. By empowering companies to rigorously assess, enhance, and transparently report their plastic footprints, we aim to make significant strides in mitigating the plastic pollution crisis.

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Plastic Footprint Network

This working group was established to develop a scientifically robust and practical methodology for accounting and categorizing mitigation actions It follows PFN's structured process, ensuring scientific integrity, peer review, and alignment with global standards.

Working group lead

(Responsible for developing the methodology, ensuring scientific rigor, and managing the working group)

evea

Contributing companies

(Experts, stakeholders, and industry representatives, who provided insights, data, or case studies to inform the methodology)

earth action

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ea for impact

The Plastic Footprint Network is convened by EA for Impact, the non-profit arm of Earth Action.



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