Politechnika Częstochowska

Wydział Inżynierii Mechanicznej i Informatyki

plast invent 2022

Tworzywa Biodegradowalne – Wady i Zalety Stosowania

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Politechnika Częstochowska

Plan prezentacji :

- Zużycie materiałów polimerowych,
- Tworzywa biodegradowalne,
- Aplikacja i zastosowanie tworzy biodegradowalnych

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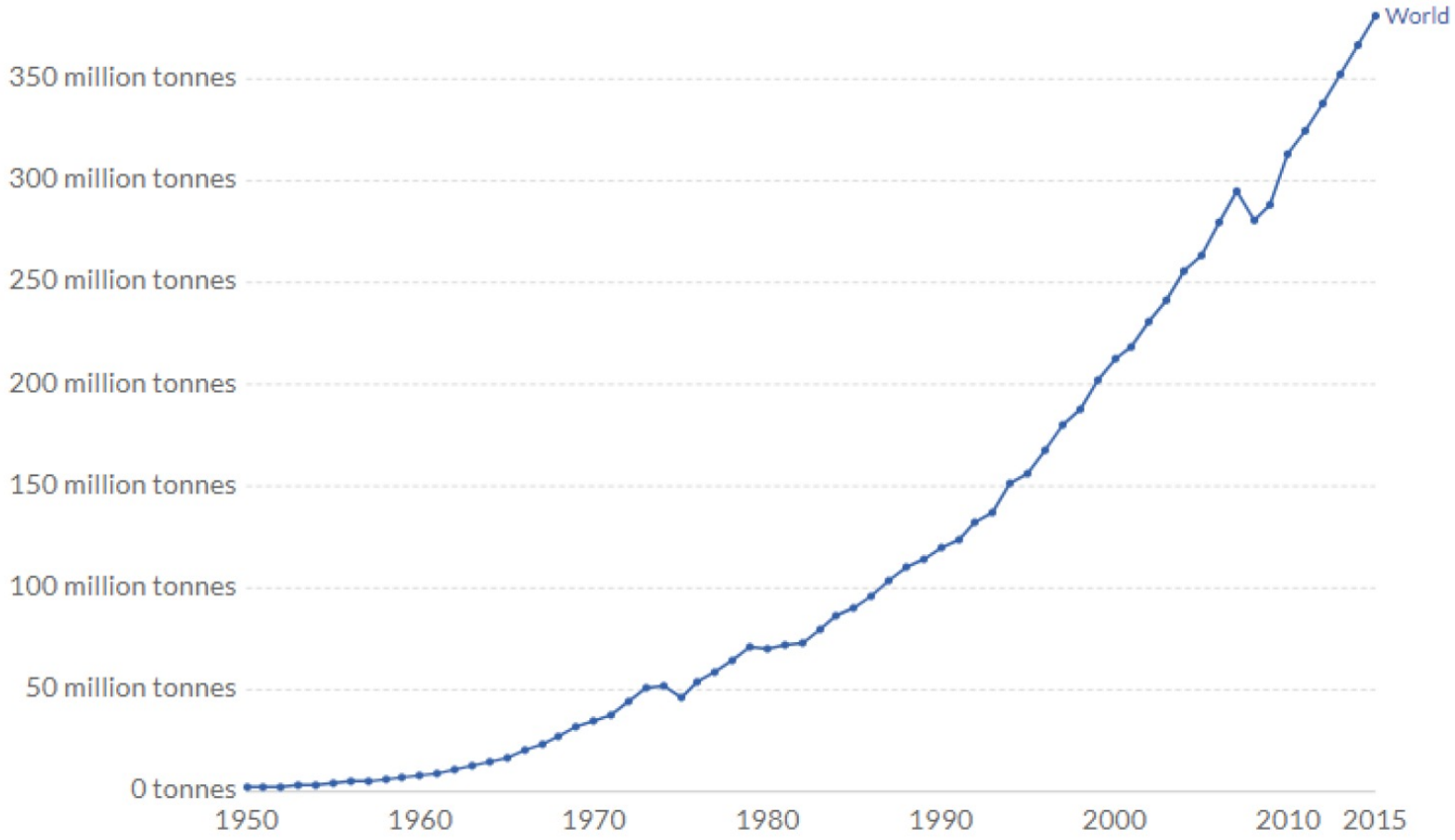

SOURCE:Global plastics production. Annual global polymer resin and fibre production (plastic production), measured in metric tonnes per year. Retrieved from: (Geyer, Jambeck et al. 2017)

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Przetwórstwo tworzyw sztucznych jako gałąź przemysłu

ŚWIAT

2016	2017	2018	2019	2020
335	349	359	368	367

mln. ton

EUROPA

2016	2017	2018	2019	2020
60	64,4	61,8	57,9	55

mln. ton

Źródło : opracowanie własne na podstawie danych https://plasticseurope.org/

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Przetwórstwo tworzyw sztucznych jako gałąź przemysłu

CHINY	32 %
NAFTA	19 %
AZJA (z yłączenim CHIN)	17 %
EUROPA	15 %
AFRYKA i BLISKI WSCHÓD	7 %
AMERYKA ŁĄCIŃSKA	4 %
JAPONIA	3 %
WNP	3 %

367 mln ton

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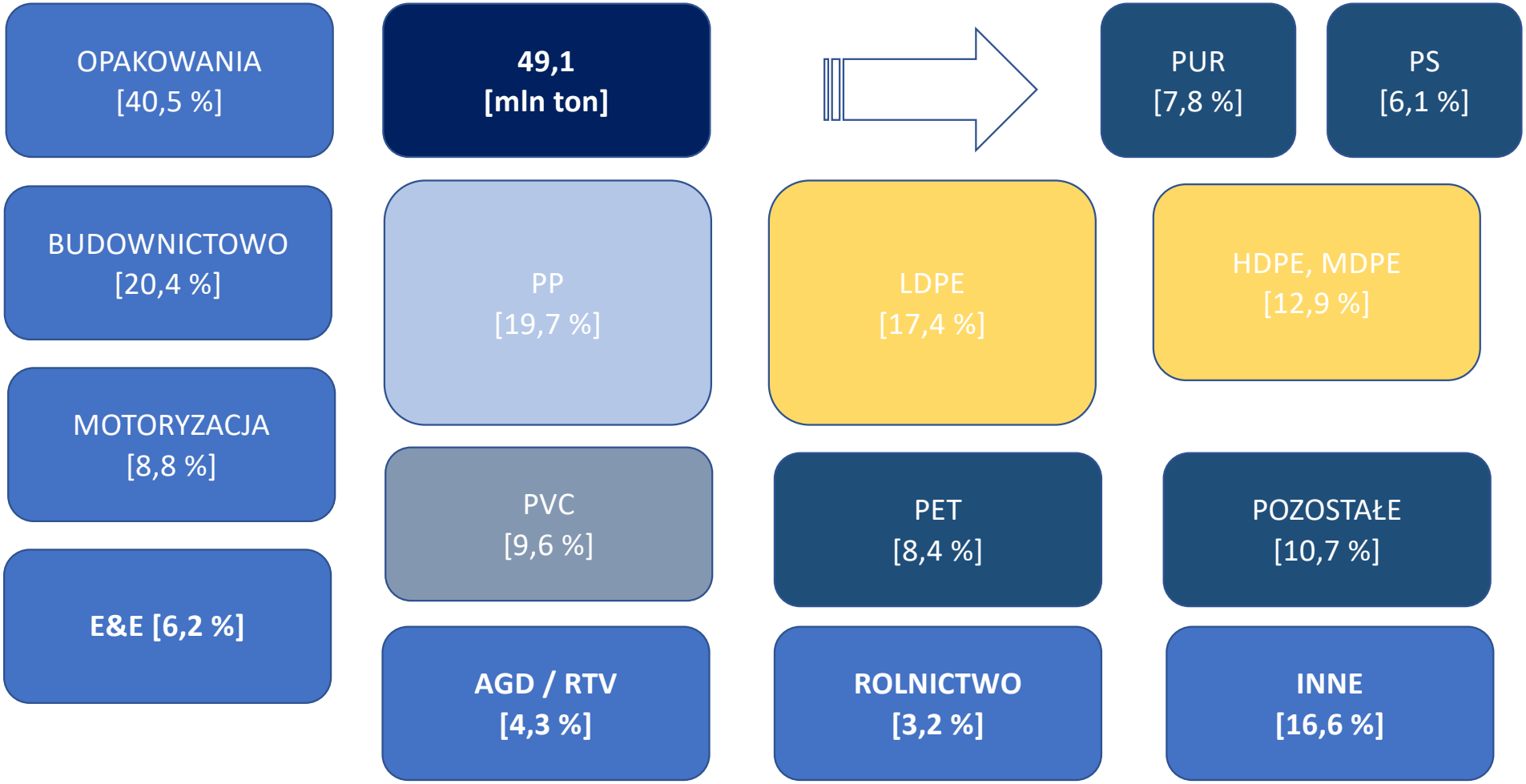
Źródło : opracowanie własne na podstawie danych https://plasticseurope.org/



Źródło : opracowanie własne na podstawie danych https://plasticseurope.org/

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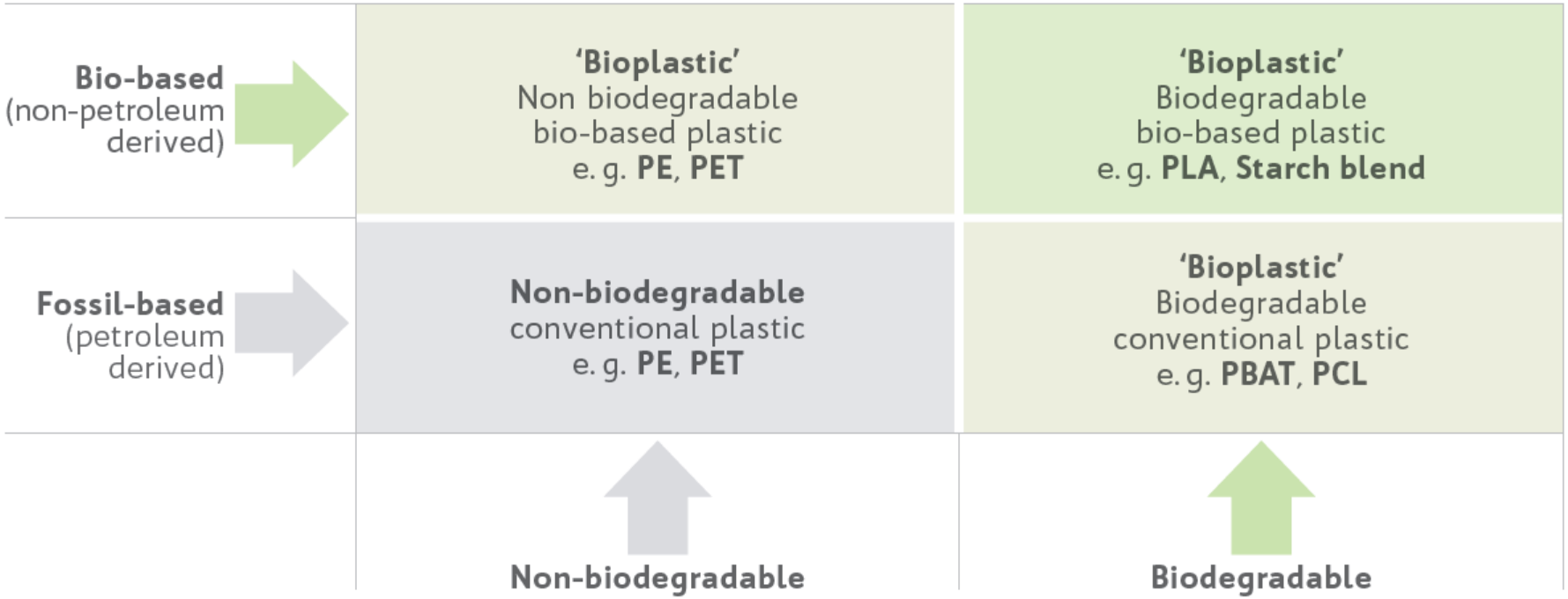
The relationship between the terms bioplastic, biodegradable and bio-based



Source: FAO, 2021.

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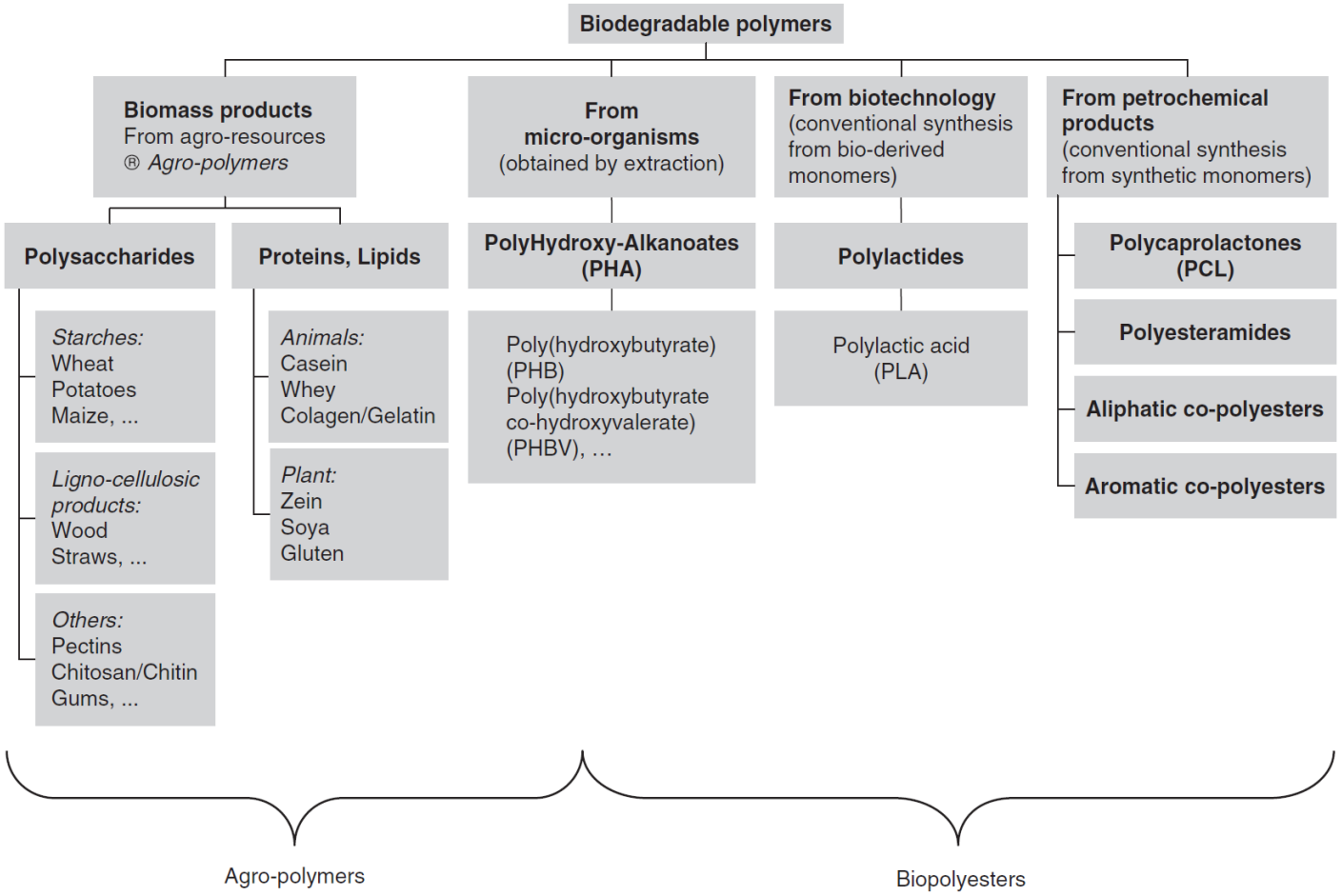
Classification of the biodegradable polymers.



SOURCE : Handbook of Biopolymers and Biodegradable Plastics strona 172

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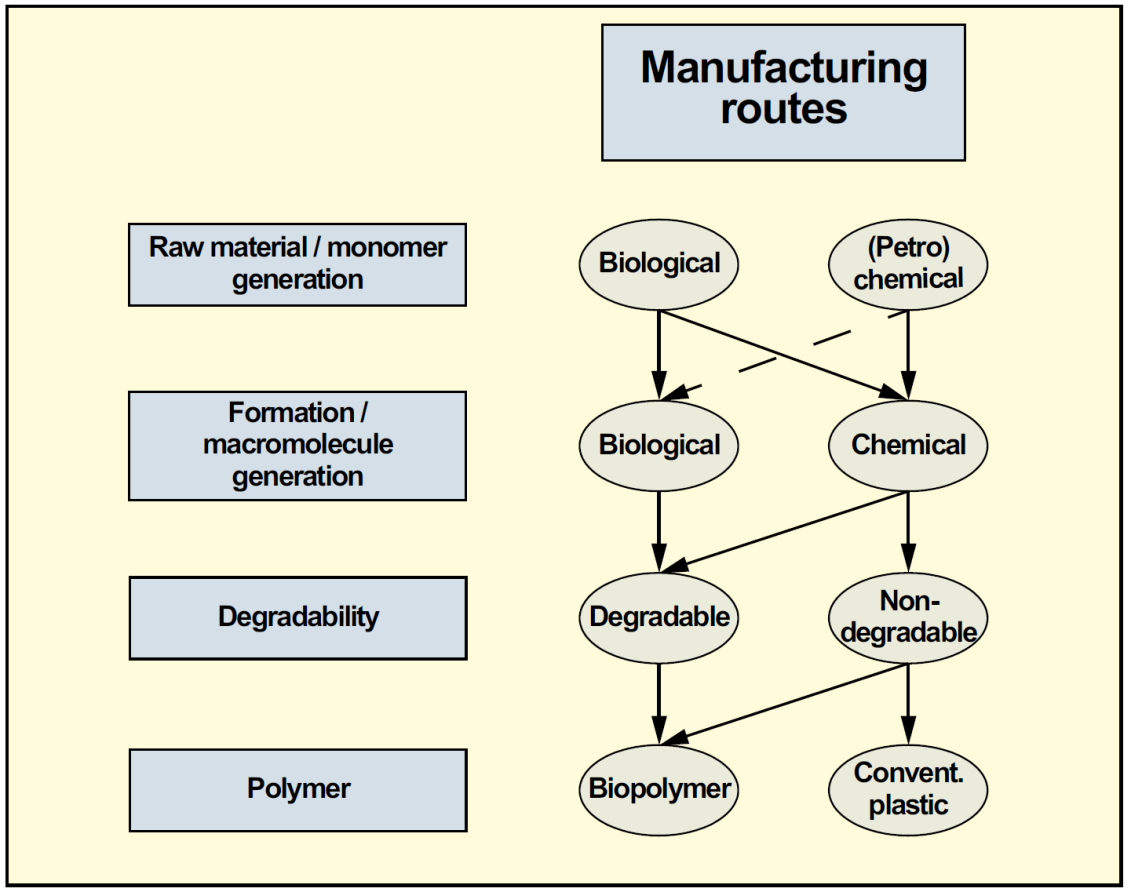
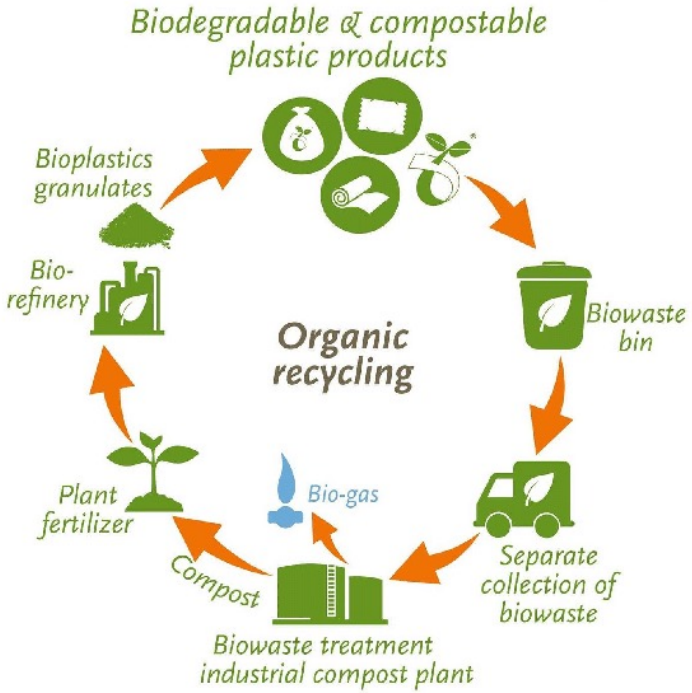
Manufacturing routes for biopolymer materials





SOURCE: Engineering Biopolymers Markets, Manufacturing, Properties and Applications by H. J. Endres, A. Siebert-Raths

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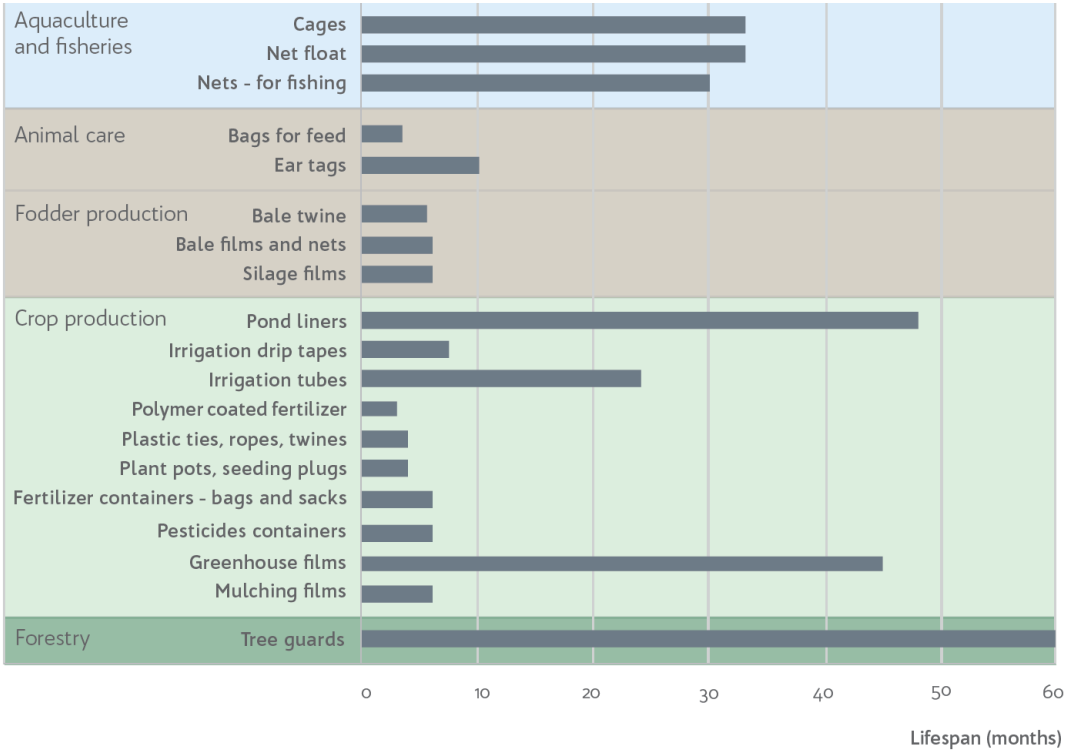
Examples of plastics used in the agricultural production of food and feed

Types of production	Groups of use	Types use	Application time *Single use*
Horticulture *e.g.* *Vegetable (olericulture)* *Orchard* *Fruit and berries*	Protective cultivation films	Greenhouse Wind tunnel Low tunnel Mulching Nursery film Direct cover Non-woven floating cover	3-4 years 6-8 months 2-4 months
Agriculture crops *e.g.* *Cereal* *Oil crops* *Hops*	Protective (conservation) films	Fumigation film Silage film Bale wrap film	Days to weeks 6-12 months 6-12 months
Livestock *e.g.* *Cows* *Sheep* *Poultry*	Nets	Anti-hail Anti-bird Wind breaking Shading Net for olives and nut picking	
	Twine	Bale twine String Rope	6-12 months 4-6 months 4-6 months
	Piping, Irrigation, drainage	Water reservoir lining Channel lining Irrigation tape and pipes Drainage pipes	years years 8-24 months years



Used by all three sections	Direct addition of microplastics	Slow release fertilizer Polymer covered seeds Biosolids	Slow release fertilizer Polymer covered seeds Biosolids	Slow release fertilizer Polymer covered seeds Biosolids	Slow release fertilizer Polymer covered seeds Biosolids	
	Packaging (nonfood)	Fertilizer sacks Agrochemicals cans Nursery pots Tanks for liquid storage Crates	Nursery pots	Nursery pots	Fertilizer sacks Agrochemicals cans Nursery pots Tanks for liquid storage Crates	Fertilizer sacks Agrochemicals cans Nursery pots Tanks for liquid storage Crates

Types, uses and other information on agricultural plastics (Espí et al. 2006)

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Biodegradable agrotextiles available on the EU market, 2015

Product type	Commercial name	Producer	Material	Main characteristics	Lifespan	Main applications
Woven ground cover	Duracover[a]	BONAR Technical Fabric (F)	PLA	Extruded PLA tapes certification biobased Vincotte; conformity to ISO 12952-1:2010	3 years	Covering land besides highways or railways, for weed control in green areas
Nonwoven geotextile	Hortaflex[b]: HortaflexThermo, Horthaflex plus (with seeds), Hotaflex 400 and 300	De Sadeleir	PLA	PLA fibers Weight: 150 g/kg or up to 300–400; UV stability superior to PP and PET; natural flame retardant	3–5 years	Horticulture, geotextile, weed control, soil erosion
Jute-based ground cover	Zelotec[c]	La Zeloise	Mix of natural fibers and biopolymers	Enhanced durability compared to jute; no phytotoxic effects in the soil; good mechanical properties and UV stability		Ground cover, for protection of slopes, viticulture, forestation, green areas, fruit trees
Woven textile Ground cover	Ökolys[d]	Beaulieu International Group	PLA	Fibers: EN13432 compliant	>3 years (EN 14836/ ISO 13934-1 compliant)	To protect plants and soil against erosion
Woven textile ground cover pre-sown felt	Tenax FPV[e]	TENAX	Cellulose	Cellulose fibers 100% biodegradable; contains both seeds and fertilizers; biodegradation from 3–5 months depending on the climatic and land conditions; 250 g/m^2, 2 mm thick		Sowing grass in green areas, against erosion on slopes; lawn sown[a]

SOURCE : Soil Degradable Bioplastics for a Sustainable Modern Agriculture by Mario Malinconico

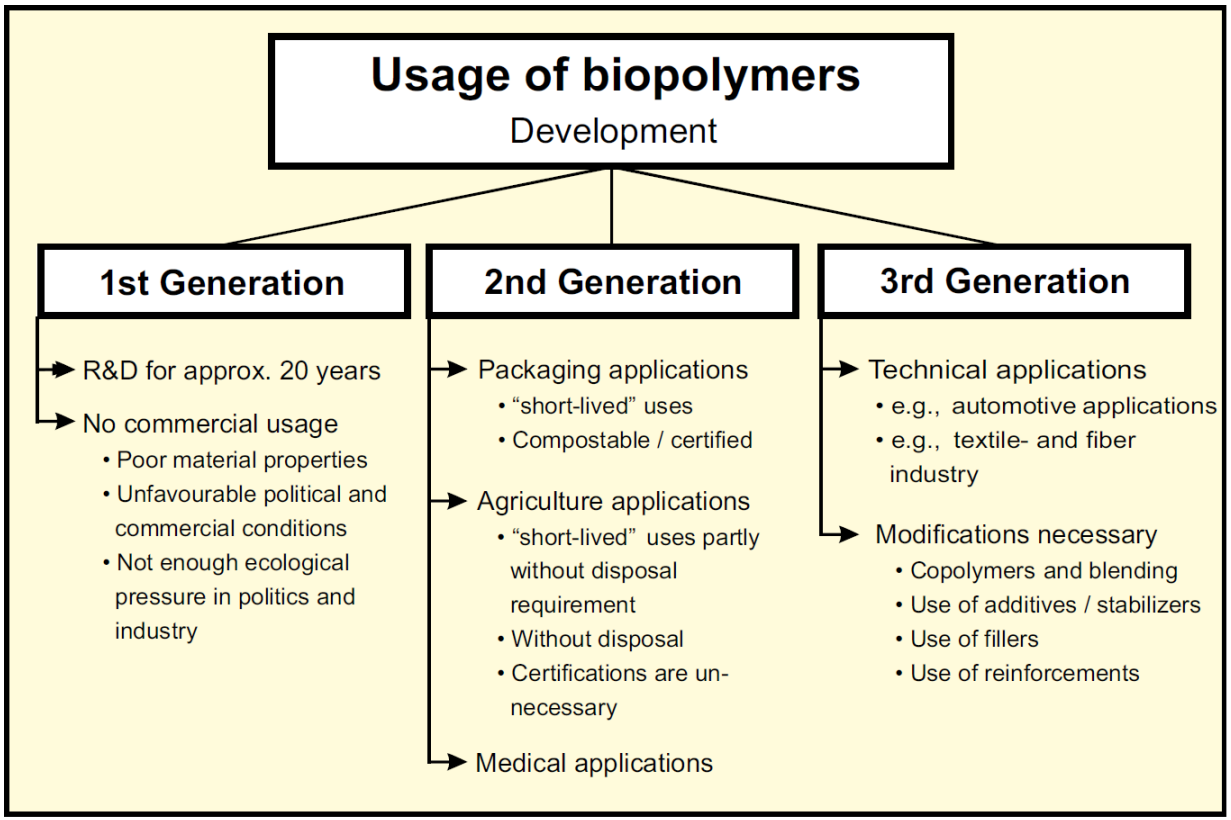
Third generation biopolymers – from degradability to durability

New Scientist 5/5/1990

„BRITAIN'S largest chemicals company, ICI, last week announced the launch of the first practical plastic that is totally biodegradable. The material, called Biopol, took 15 years to develop and Wella, an international hair-care company, plans to begin packaging shampoo in bottles made from it this month. The bottles will be available only in Germany.

ICI has used a natural polymer called polyhydroxybutyrate (PHB) which degrades to form carbon dioxide and water.

1925 - Maurice Lemoigne first identifies PHB



SOURCE: Engineering Biopolymers Markets, Manufacturing, Properties and Applications by H. J. Endres, A. Siebert-Raths

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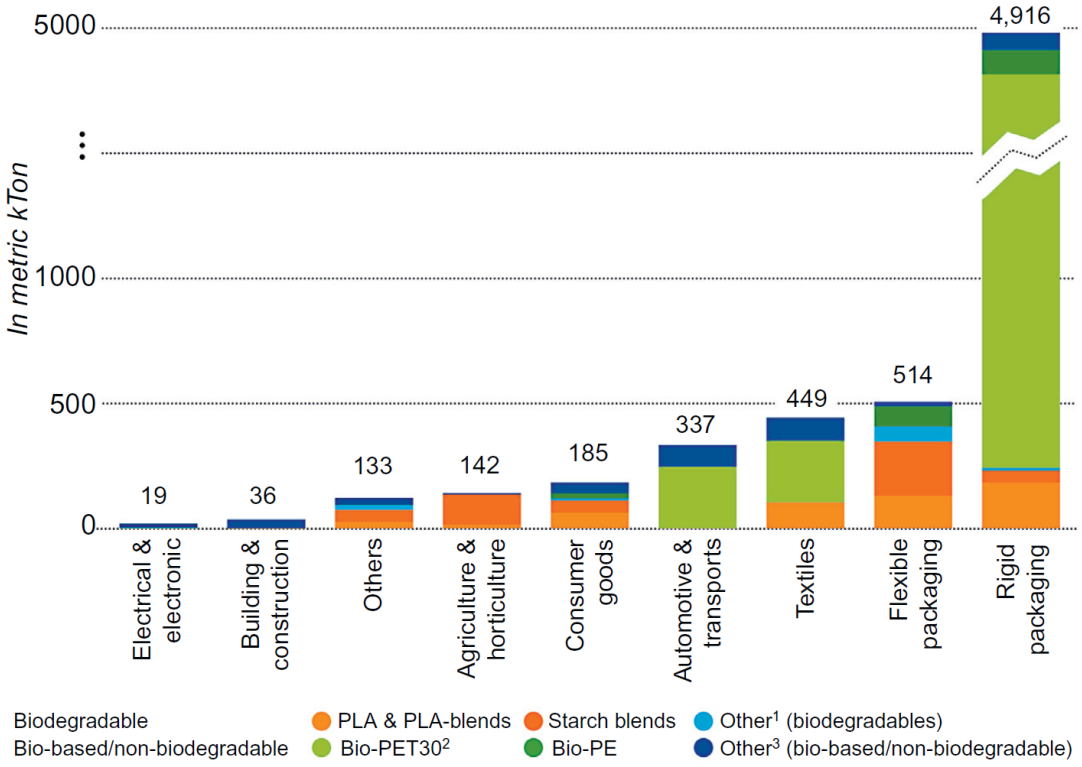

[1] Contains regenerated cellulose and biodegradable cellulose ester [2]Biobased content amounts to 30% [3]Contains durable stratch bends, Bio-PC, Bio-TPE, Bio-TPE, Bio-PUR (except thermosets), Bio-PA, PTT

Global production capacities of bioplastics by 2018. European Bioplastics, Institute for Bioplastics and Biocomposites, nova-Institute (2014). More information: www.bio-based.eu/markets and www.downloads.ifbb-hannover.de.

SOURCE : Introduction to Bioplastics Engineering by Ashter, Syed Ali

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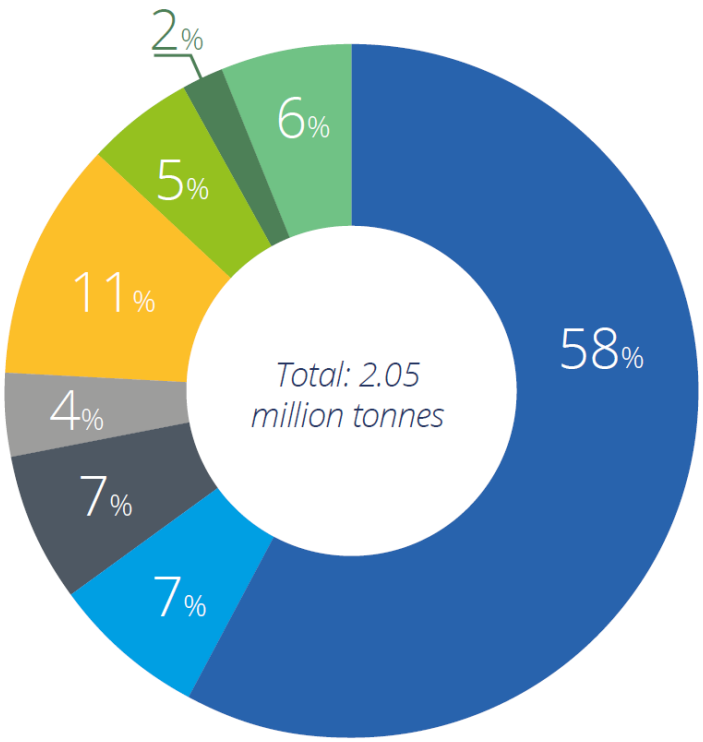
Biodegradable polymers in the agricultural sector



By market segment

- Packaging (flexible and rigid)
- Consumer goods
- Automotive and transport
- Construction
- Textile
- Agriculture and horticulture
- Electric-electronic
- Other

Biodegradable materials provide an alternative for solving the problem of managing waste generated in plasticulture. The use of bio-degradable materials is currently on the rise and global production is expected to increase from 2.05 million t in 2017 to 2.44 million t in 2022

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Five percent of global production of biodegradable plastics is intended for the agricultural sector, and the ones most commonly used in the sector include polyhydroxyalkanoates (PHAs) and their derivatives, polylactic acid (PLA) and its blends with bio-polyesters, and starches and their blends with bio-polyesters.

By type of material

Bio-based/non-biodegradable
57,1%

Other bio-based/ non-biodegradables

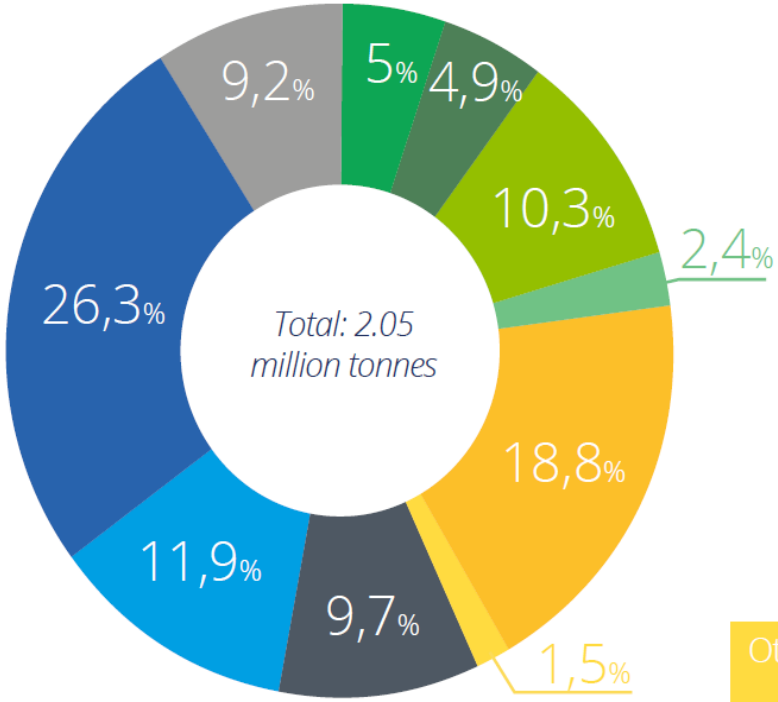
PET

PA

PE

PEF*

PP*



Biodegradable
42,9%

PBAT

PBS

PLA

PHA

Starch blends

Other biodegradable materials

*PP and biological based FEM are currently in development and are expected to be available on a commercial scale in 2020.

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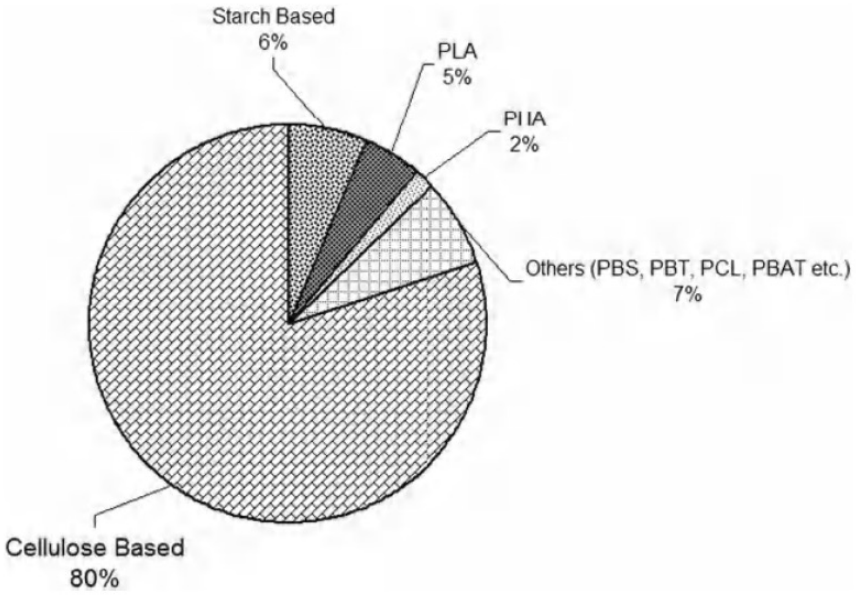
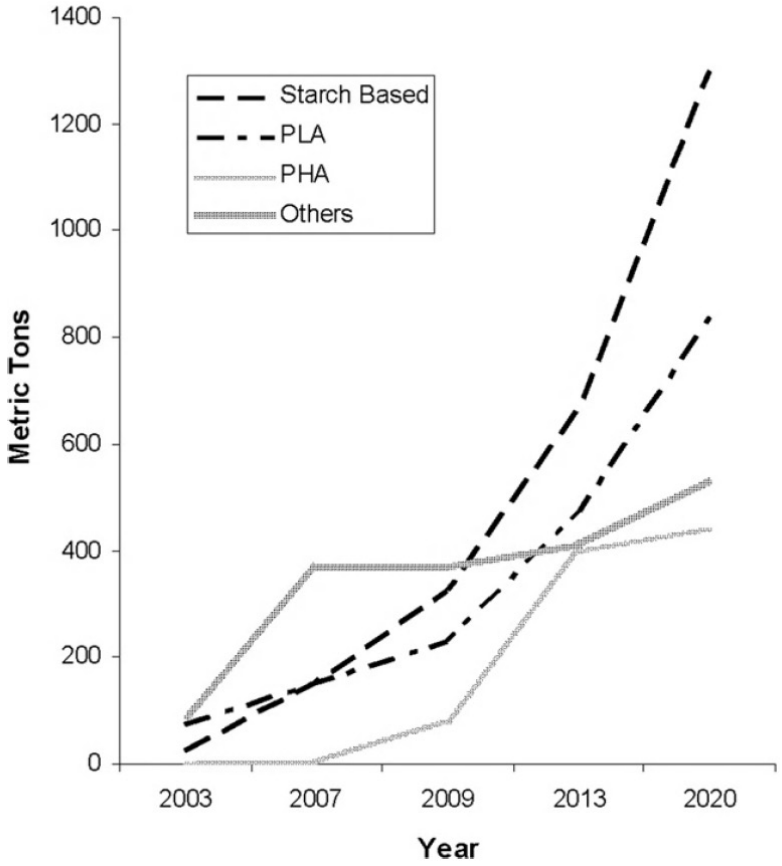


World production of renewable biode-gradable plastics in 2009



World production of renewable biode-gradable polymers in 2003-2020 (projected)

SOURCE : Handbook of Biopolymers and Biodegradable Plastics

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Comparison of the Properties of Bionolle and LDPE, HDPE, and PP

Properties	Bionolle (#1001)	Bionolle (#3001)	LDPE	HDPE	PP
Glass transition (°C)	−32	−45	−120	−120	5
Melting point (°C)	114	94	110	129	163
HDT (°C)	97	69	88	110	145
Tensile strength (MPa)	57	47	35	39	44
Yield strength (MPa)	32	19	12	27	31
Flexural modulus (MPa)	656	323	176	1070	1370
Strain at break (%)	700	900	400	650	800
MFR at 190 °C (g/10 min)	1.5	1.4	2	2	4

Source: Data adapted from http://www.shp.co.jp/en/bionolle_data1.htm

Definitions of Compostability According to ASTM D6400

Compostable Plastic A plastic that undergoes degradation by biological processes during composting to yield carbon dioxide, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials and leaves no visually distinguishable or toxic residues.

Composting A managed process that controls the biological decomposition and transformation of biodegradable materials into a humus-like substance called compost: the aerobic mesophilic and thermophilic degradation of organic matter to make compost, the transformation of biologically decomposable material through a controlled process of biooxidation that proceeds through mesophilic and thermophilic phases and results in the production of carbon dioxide, water, minerals, and stabilized organic matter (compost or humus). Composting uses a natural process to stabilize mixed decomposable organic material recovered from municipal solid waste, yard trimmings, biosolids (digested sewage sludge), certain industrial residues, and commercial residues.

Degradable Plastic A plastic designed to undergo a significant change in its chemical structure under specified environmental conditions, resulting in a loss of some properties that may be measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification.

Definitions of Compostability According to ISO 17088

Compostable Plastics A plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials and leaves no visible, distinguishable, or toxic residue.

Composting The autothermic and thermophilic biological decomposition of biowaste (organic waste) in the presence of oxygen and under controlled conditions by the action of micro- and macroorganisms in order to produce compost.

Compost Organic soil conditioner obtained by biodegradation of a mixture consisting principally of vegetable residues, occasionally with other organic material and having a limited mineral content.

Disintegration The physical breakdown of a material into very small fragments.

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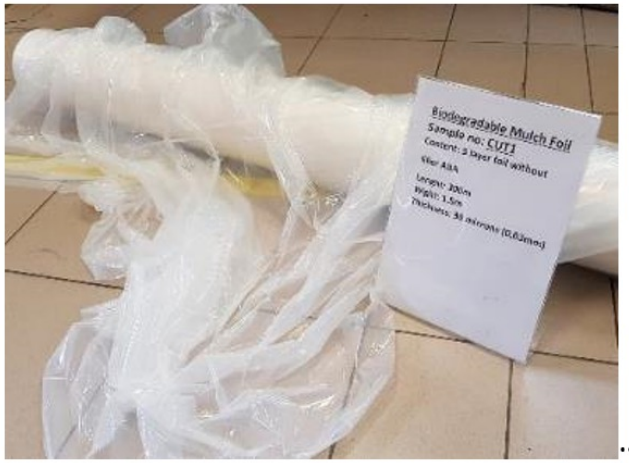

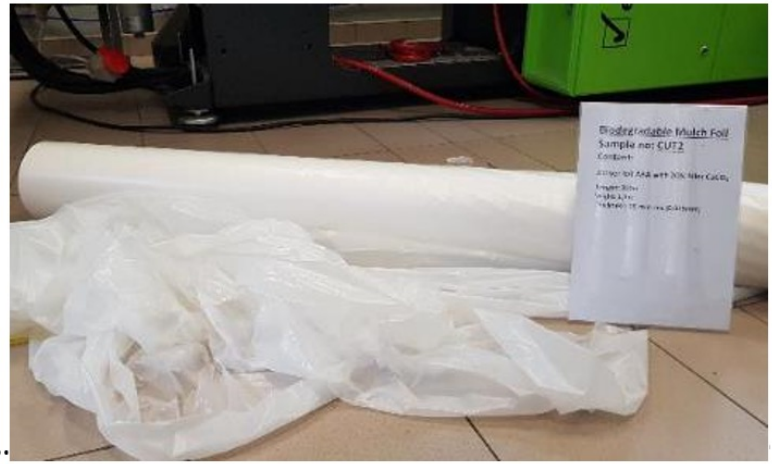

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Types of material	Production costs (per 1000 pieces)	Waste management
Biodegradable supports 	28-38 EURO* depending on the cost of machine work	Can be mulched and mixed with with plant residues and left for decomposition
Polyethylene supports 	21 EURO	Cannot be mulched and mixed with plant residues – have to be collected, washed and disinfected from plant residues, fungi and bacteria prior to residues, fungi and bacteria

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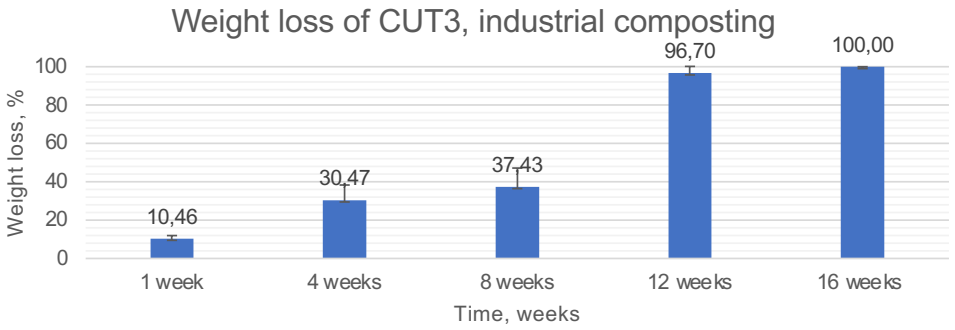

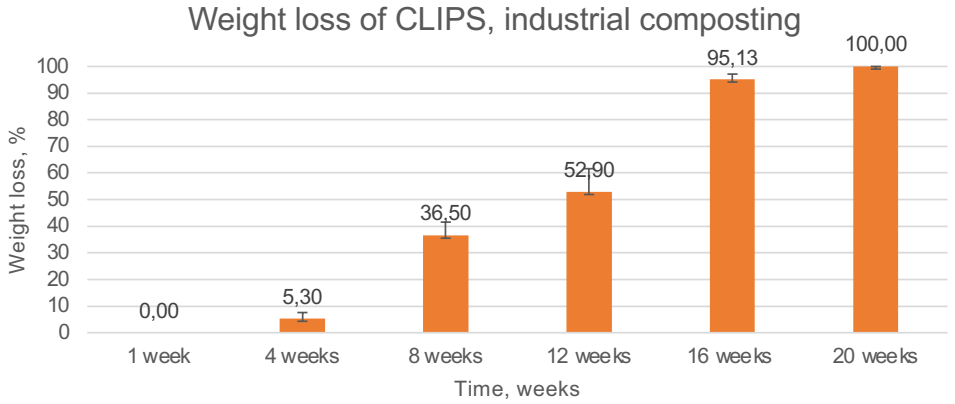

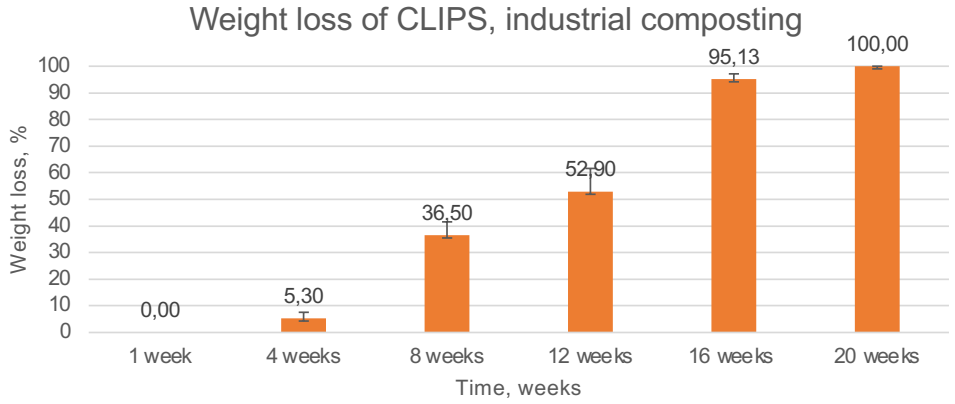

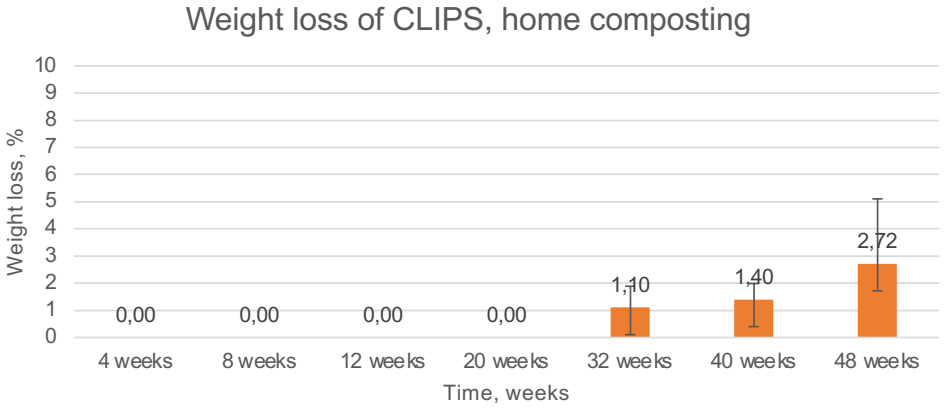

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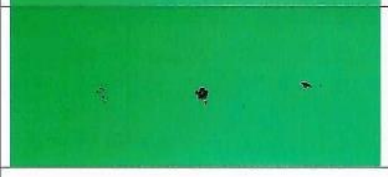
	30/1	30/2
after 1 week of biodegradation		
after 4 weeks of biodegradation		
after 8 weeks of biodegradation		
after 12 weeks of biodegradation		
after 16 weeks of biodegradation	Biodegradation 100%	
after 20 weeks of biodegradation		Biodegradation 100%

	CUT3	CLIPS
after 4 weeks of biodegradation		
after 8 weeks of biodegradation		
after 12 weeks of biodegradation		
after 20 weeks of biodegradation		
after 32 weeks of biodegradation		
after 40 weeks of biodegradation		
after 48 weeks of biodegradation		

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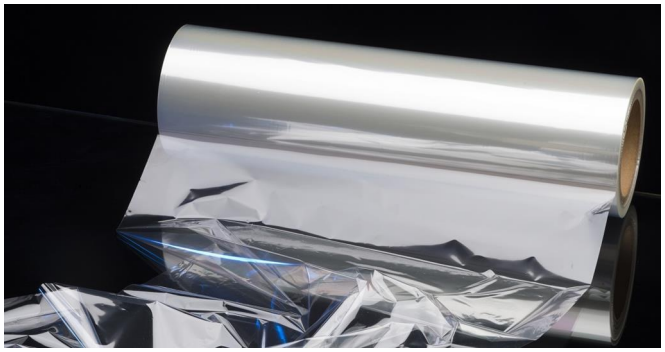
Podsumowanie i wnioski

- Cena Zakupu materiału
- Cena gotowego wyrobu
- Przetwarzanie i przetwarzalność
- Dobór polimeru biodegradowalnego do aplikacji
- Żywotność – czas do degradacji
- Sposób kompostowania – kompostowanie przyfomowe vs. Kompostowanie przemysłowe
- Świadomość społeczna – polimer biodegradowalny to nie polimer klasyczny
- Segregowanie odpadów
- Regulacje prawne



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Dziękuję za uwagę

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