



Sustainable polymers for packaging

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Overview

- Sustainable society
- Biobased society
- Sustainable packaging
- Polymers for packaging
- Wastes and coproducts to polymers
- Food versus biobased: Competition
- Conclusions



Sustainable society

- **Human behavior**

Travel, energy consumption, waste generation

- **Resource use**

Water, biomass, waste, fossil oil, sun, wind, hydro, wave

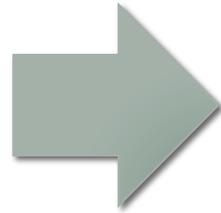
- **Environmental Impact**

Water quality, deforestation, air pollution, carbon dioxide emissions, methane, land management



Biobased society

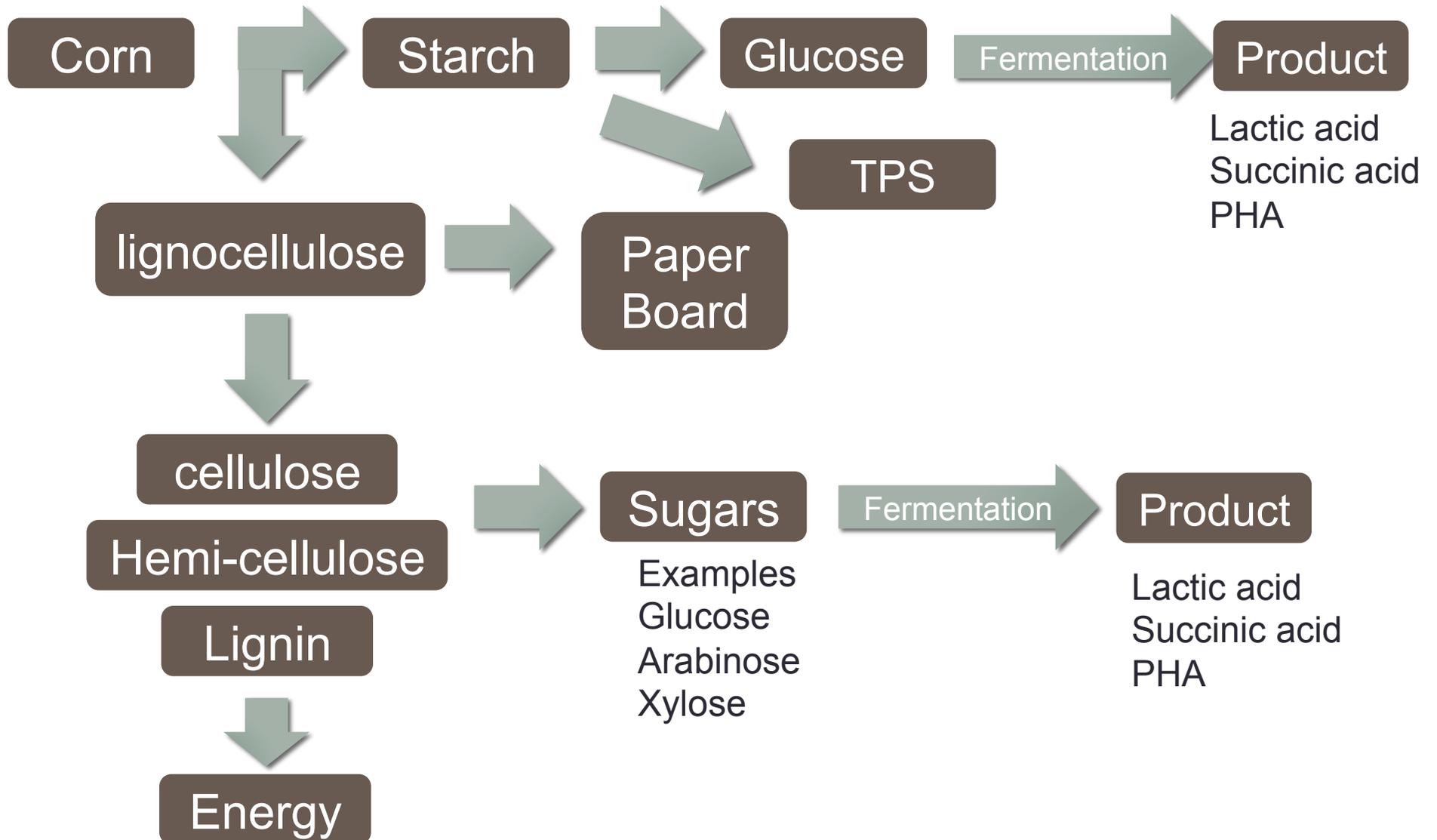
Biobased
resources
(1000's years)



- Polymers
- Paints/dyes
- Chemicals
- Adhesives
- Fuels/energy
- Food
- Medicines



Routes to biobased biopolymers





Biobased society

- In 2000 >98% of the energy and chemicals were based on fossil resources as raw materials.
- In 2100 >95% of the chemicals and polymers could be based on renewable resources.*
- The question for bio-based polymers is not “if?”, but “when?”, despite many years of unfulfilled promises (1990-2005).

*Strong government support in many countries around the world.



Sustainable packaging

Resources

Production process

End of life management

Biobased \neq biodegradable \neq compostable

Fossil based \neq non biodegradable

Labeling and standards – EN 13432



Sustainable packaging

- **Design**
 - Protection of product
 - Preservation of product
 - Display of product
 - Transport of product
 - Resource efficiency
 - End of life management - Reuse, Recycle, Composting
- **Resource management**
 - Packaging = disposable, non degradable, limited recycling options
 - Fossil based plastic predominates



Polymers for packaging

Biobased and non compostable

- Biobased PET
- Biobased polyethylene

Fossil based and compostable

- Polybutyrate adipic terephthalate (PBAT)
- Polycaprolactone (PCL)



Packaging choices

Property	PLA	PET
Biobased	+	-/+
compostable	+	-
Gas barrier	-	+
Recyclable	+	+

Is PLA needed for plastic bottles where plastic waste from (water) bottles for example is relatively clean and thus easily recyclable?

Is PET a poor choice at major sporting events with mixed food waste? Compostable food and PLA



Wastes and byproducts to polymers

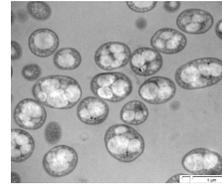


Plastics

Chemistry



Fermentable
Oil/solid



Microbiology



PHA

Waste
Cooking oil

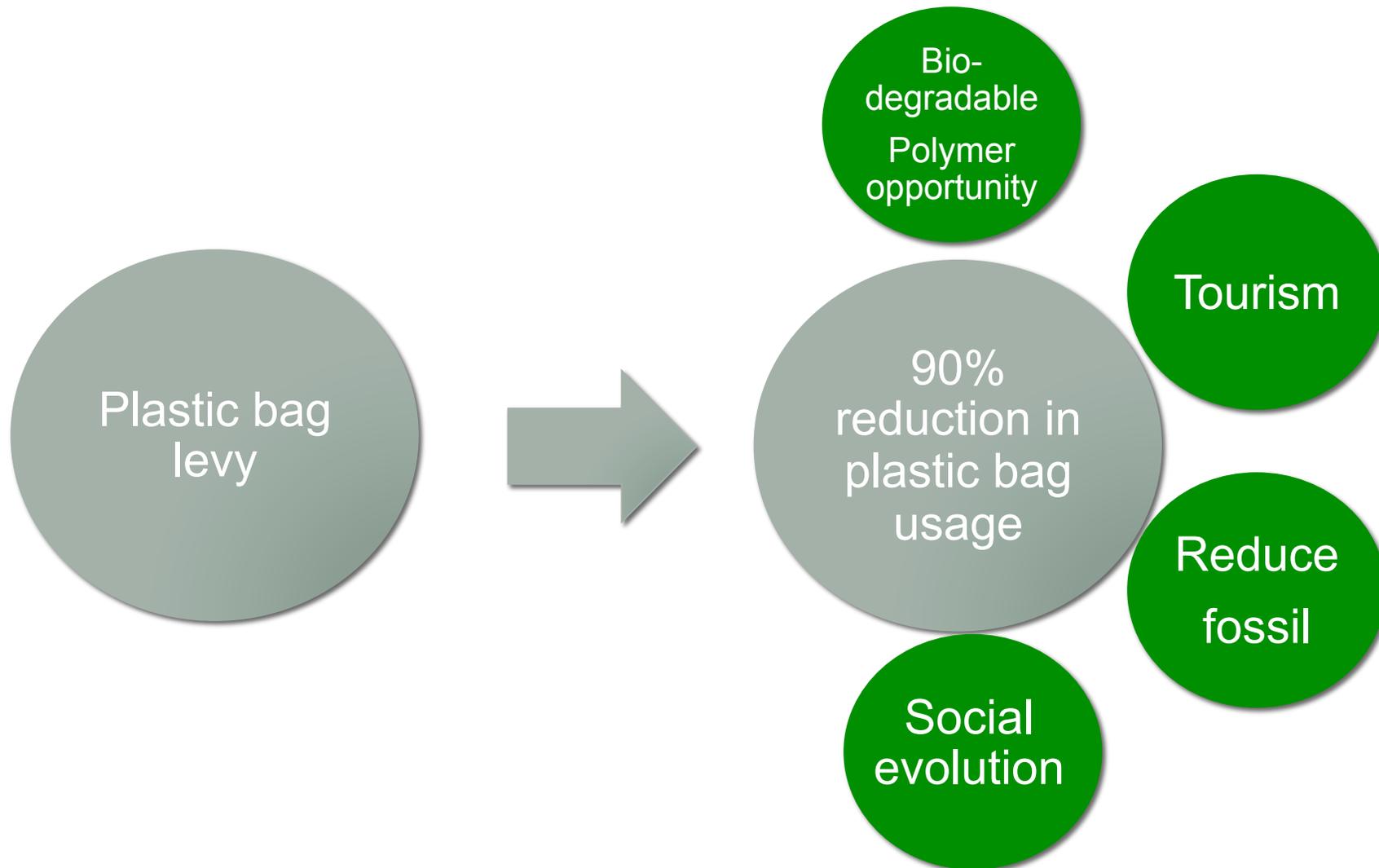
Microbiology



PHA



Policy and human behavior





Food v biobased: competition

- 3.6% of total land usage for set aside land and industrial crops needed for biopolymer production.
- Bio-based polymers will not cause any strain within the EU on agricultural land requirements in the near future.
- There could be some conflict of interest with bioenergy crops for utilisation of set aside or industrial crop land
- Policy designed for bioenergy alone is counter productive



Conclusion

- The biobased options to make existing and new polymers for packaging exist
- Performance of new polymers is still a challenge for packaging.
- Sustainability is complex and choices exist within
- Policy, standards, labeling are key pillars of sustainable packaging