WP4. Techno-economic assessment - natural resource use -

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Introduction

The sustainable development of the bioeconomy is coupled with efficient use of natural resources across the whole value chains of bio-based products. Concurrently, sustainable bio-based production has to balance a trade-off between economic, environmental and social benefits. The manufacture of bio-based products is directly and indirectly associated with ecosystem provisioning services by inputs of renewable and non-renewable materials and other biotic and abiotic resources. The exploitation of resources is associated with regulating services that tend to compensate for the interference in the ecosystem (Fig.1). Accordingly, the indicators on natural resource use efficiency in TESA should be accompanied with adequate environmental, economic and social indicators assuming life-cycle impact assessment.

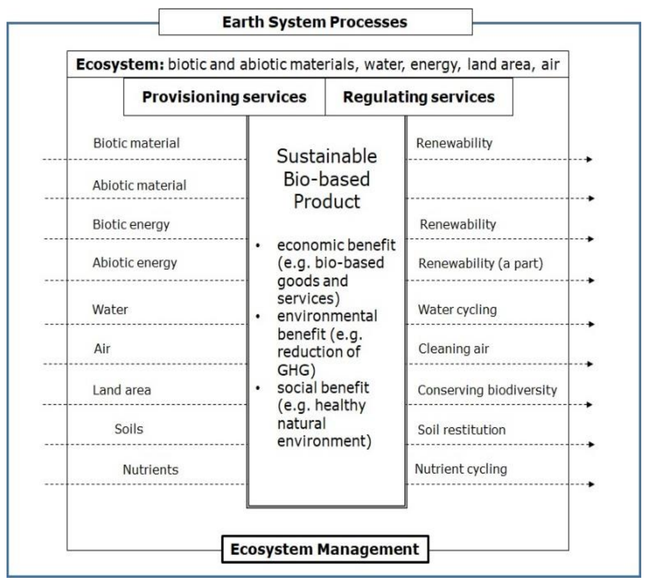

Figure 1. Ecosystem context of natural resource use in TESA

Raw material – primary or secondary material that is used to produce a product (ISO 14040:2006).
Note 1: Secondary material includes recycled material. (ISO 13065:2013)
Note 2: Raw material includes agricultural residues, forest residues and processing residues (ISO 13065:2013)
Raw material feedstock – main chemical compound of raw material processed to bio-based material (e.g. PLA) or product (e.g. PLA-based much film)
TEA – Techno-Economic Assessment
TESA – Techno-Economic Sustainability Assessment

Objectives

- to discuss the concept of decoupling natural resource use from economic activity and economic activity from environmental impact as well current policy and regulations;
- to provide a set of non-LCA resource efficiency indicators and indicative values for PLA production (case studies).

Methodology

The overview of natural-resource-use-related key elements and life-cycle activities within the TEA of bio-based products is sketched in Figure 2. Those activities begin and end in the ecosystem. They are associated with input-output TEA and the estimation of internal product-related life cycle assessment costs as well as the costs imputed to environmental, economic and social externalities.

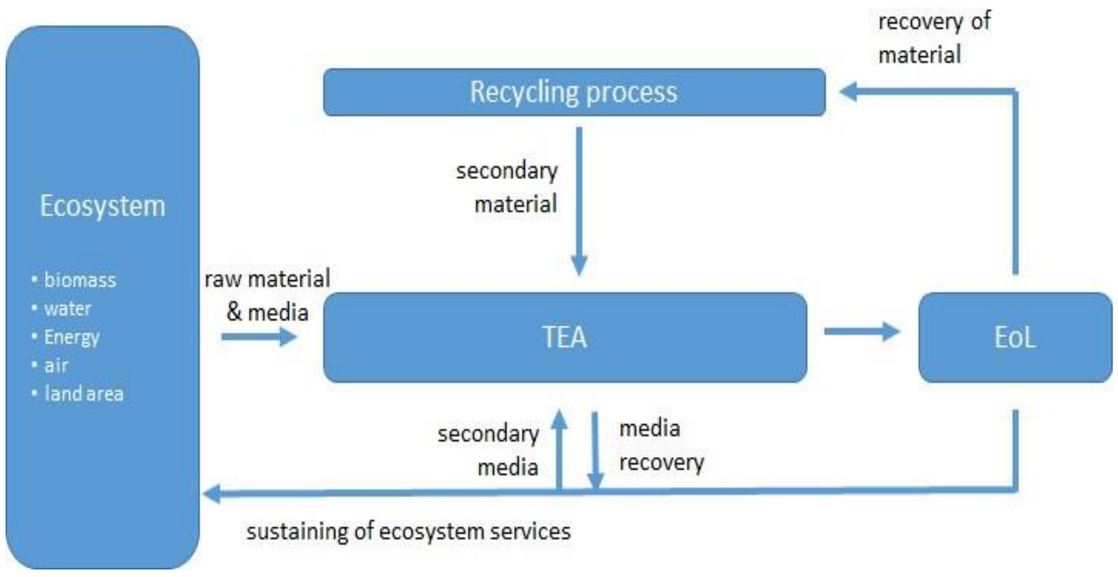

Figure 2. The generic scheme of integrated resource related elements and activities within TEA

Results

The principle, criterion and indicators of natural resource use presented in Table 1 are in accordance with the principles and criteria of the current standards addressing bioenergy and bio-based products ISO 13065:2015 and EN 16751:2016, respectively. The extension is related to the non-LCA indicators for assessment of natural resource use efficiency in bio-based production[1]. A preliminary criterion for selection of indicators was the reliable source and availability of input data and their quality as well as an aspect of universality in the assessment of various bio-based resources and products[2].

Table 1. Principle, criterion and non-LCA indicators for natural resource use in TEA

Principle	Criterion	Indicators
1. Promote efficient use of natural resources	1.1. Economic operator provides information on how the efficiency of land, raw material, energy and water use is addressed in TEA	1.1.1. Describe measures taken to assess raw material use efficiency
		1.1.2. Describe measures taken to assess raw material related energy use efficiency
		1.1.3. Describe measures taken to assess raw material related water use efficiency
		1.1.4. Describe a measure taken to assess raw material related land use efficiency

The implementation of TEA indicators associated with natural resource use to a STAR-ProBio case study is associated with processing of sugar beet and maize to bio-based material – polylactic acid (PLA) (Fig.3). PLA is one of the highest use polymers in bioplastics including decomposable packaging materials and mulch film. In the EU climatic conditions the most efficient raw material feedstock for PLA production can be sugar acquired from sugar beet (sugar crop) followed by starch acquired from maize (cereal crop).

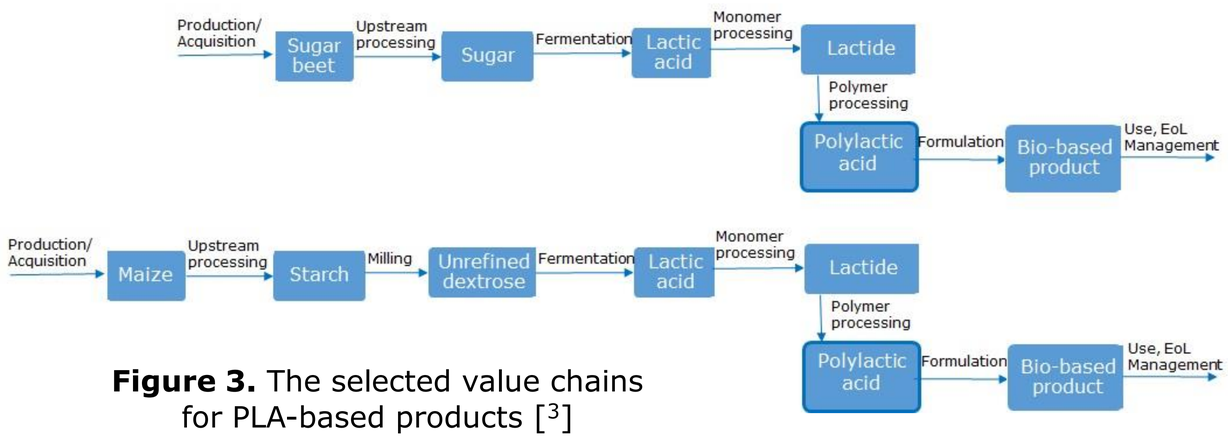

Figure 3. The selected value chains for PLA-based products [3]

Conclusions

- The raw material feedstock per hectare basis of sugar beet is 3-times more efficient than from maize.
- The land use per ton of PLA accounts for 0.14 and 0.39 ha for sugar and starch production, respectively.
- The share of energy use associated with sugar beet production per ton of PLA was 2.5 times lower than in the case of maize.
- At the same time the raw material based water use per t of PLA contributes with a similar values 1680 and 1609 m^3/t PLA for sugar beet and maize production, respectively.
- In order to develop TESA those values should be completed with LCA, LCC and s-LCA.

WP4 partners

- **natural resource use**

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References

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