Pineapple leaves for high quality fibre and other biobased applications

Researchers
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Focus
This project explores the use of pineapple crop residues for fibers and other bio-based valorisation options. Based on the understanding of current agronomic, technical, economic, social-institutional and governance bottlenecks involved in the pineapple residue transitions solutions are identified to deal with these bottlenecks.

Innovative idea and objective

We studied the case of pineapple residues as potential feedstock for new carbon-based materials. Pineapple crop residues are an environmental burden and their disposal an important cost for the pineapple industry. Residues left in the field attract the blood-sucking stable fly, which feeds and multiplies on the residues. Nearby cattle may be infected by the flies which affect their (milk) production. Current crop residue management is based on using combinations of herbicides, pesticides, burning, shredding, and even potholing is sometimes used.

The use of pineapple residues as feedstock for biomaterials could create potentially a win-win situation: The pineapple industry can add value to crop residues whose management is costly and environmental unfriendly. At the same time, the residues are a potentially valuable feedstock for various biomaterials contributing to the bioeconomy. Using the pineapple case from Costa Rica, the objectives of the study were to:

- Identify pineapple residue components and application options with focus on textiles.
- Illustrate a cascade of application options for pineapple residues with the focus on total use.
- Understand the agronomic, technical, economic, social-institutional bottlenecks hampering the transition towards a biomaterial transition in the case of Costa Rica.

Relevance to the materials transition in textiles and/or building materials?

Pineapple crop residues contain many components that have a potential application in the bioeconomy. This study focused on the pineapple leaf fibers (PALF) as potential feedstock to be used in the textile industry. Yet, we also addressed the use of PALF for other biomaterials and we identified other residual components because only 10-20% of the dry matter of the pineapple leaves consists of PALF. The remaining residual biomass has to find an application (in the bioeconomy) for the economic viability and optimizing the sustainable use of PALF in the textile industry.

What did you do?

We described the context of current pineapple production and residue management in Costa Rica. We estimated the annual amount of residual pineapple biomass available for biobased applications. We made a systematic inventory of potential pineapple residue applications allowing to cascade different options and optimizing the use of PALF. Based on a desk study, the fiber characteristics of PALF have been characterized and we quantified the potential amounts of PALF and biogas that can be produced annually in Costa Rica based on the residues that are currently disposed. We further identified a number of bottlenecks that constrain the development of valorization of pineapple residues in Costa Rica.

Main result, achievement and highlight

We identify five major valorization areas in which pineapple residues can be applied: i) Fibers for paper, insulation material, and textile; ii) Chemical compounds that can be extracted such as bromelain; iii) Animal feed for ruminants; iv) Substrate for producing gum, mushrooms, etc.; And v) Energy (bioethanol or biogas). We estimated that annually 620,000 t dry matter of pineapple residues in Costa Rica is available for valorization applications, which would allow to produce between 45,800 and 91,600 t of PALF annually, depending on the ranges of fiber contents of pineapple leaves found in the literature. At the same time, the crop residues would be able to generate an amount of biogas equivalent to 23 million kg LPG.

These valorization options are promising as they allow scalable and cascading of solutions for the various valorization areas identified. A number of bottlenecks have been identified that hinder their further development: i) The true costs of current pineapple crop residue management are largely unknown but if known could speed up transformation processes; ii) Lack of disciplinary knowledge relevant for developing specific valorization options; iii) The lack of sound business models allowing investors to step in; And iv) the lack of an enabling environment that stimulates the development of valorization options, for example, energy production from pineapple residues.

Key message

Biobased applications of pineapple residues have a great potential to create win-win solutions by improving the environmental footprint of pineapple production and providing large amounts of biomass including fibers for material transformation to phase out fossil fuels.

Visual abstract

From left to right : From pineapple production, pineapple stubble to the extraction of fibers from pineapple leaves.