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Skjold, Else; Richardy, Jesper; Niinimäki, Kirsi; Cura, Kirsti

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From Soil to Garment: Missing Links in the Assessment Criteria of Textiles

Else Skjold[(a)], Jesper Richardy[(b)]
a) the Royal Danish Academy, Copenhagen, Denmark
b) the Royal Danish Academy, Copenhagen, Denmark

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Abstract:

The EU textiles strategy of 30th of March 2022 is set to be implemented within a 5-year period. In the strategy, it is the ambition to build a sector wherein '*Consumers benefit longer from high quality affordable textiles' (European Commission 2022)* within 2030. It is particularly these elements of the EU strategy that this paper comments on, with a particular focus on the environmental impact in the beginning of the lifecycle of plant-based textile fibers, and how these affects longevity-related properties in the use phase.

The paper elucidates discrepancies between assessment criteria within agriculture and textile certification schemes and highlights consequences of these in relation to firstly, how textiles are assessed today, secondly, how assessments are being understood and practiced within industry (here in Denmark), and thirdly, what this means for longevity of textiles. Through interviews with seven textile sourcers and advisors on sustainable practices in the Danish textile industry we examined how industry insiders understand and evaluate environmental risks in their materials supply base and how they are addressing these risks. The interviews highlighted major knowledge gaps within the textile industry when it comes to encouraging sustainable practices at the beginning of the supply chain and a profound lack of linking various assessments of parameters such as environmental impact, fiber quality and durability, and hereby a deeper understanding of what a low-impact and long-lasting fiber really is.

Introduction

This paper represents preliminary insight from the project 'Regulation and Promotion of CE' that is affiliated with the Danish research partnership TRACE (trace-im4.dk). A politically funded platform for circular economy (from here: CE) within plastics and textiles initiated on the basis of a EU commitment to support mission-based research, as argued by Mazzucato (2019). One of the key ambitions of the TRACE partnership is to respond to the European strategy for plastics in a circular economy (European Commission 2018), and the EU strategy for sustainable and circular textiles (European Commission 2022). In this paper we will look into the EU textiles strategy and critically ask what kind of CE is proposed, and how we as researchers can position our work accordingly. As there are many issues addressed in the strategy, we will focus mainly on the following passage of text:

"By 2030 textile products placed on the EU market are long-lived […] *produced in respect of* […] *the environment. Consumers benefit longer from high quality affordable textiles" (European Commission 2022).*

For doing so, we would like to enquire what type of CE understanding is currently underpinning EU regulation. We here lean on the critical analysis of EU directives-, strategies-, and legislative documents for promoting CE in the period of 2011-2022 by (Alberich, Pansera, and Hartley (2023). Here, the documents are

analyzed by means of the 'four futures of circularity' model by (Bauwens et.al (2020), on the basis of which the authors conclude that most documents are based on a *circular modernism* which relies heavily on technology development and (linear) growth based on circular business models and decoupling of resources, and to an increasing extent *planned circularity* in which regulative instruments such as taxes, hard caps and bans incentivize more circular practices between production and consumption. However, more deep-rooted views on circularity that might concord with planetary boundaries such as formulated by Desing et al. (2020) are not in play at all. In this terminology, that would be a *peer-to-peer circularity* which drives on the development of technology that can foster circular sharing economies, or *bottom-up sufficiency* in which de-centralised, locally based and small-scale production aims at supporting local needs. The authors conclude that current EU policies for CE are promoting 'technocratic and productivist narratives based on a weak form of circularity' (Alberich, Pansera, and Hartley 2023). It could therefore be argued, that environmentally sound circular futures such as those suggested in early writings like *Silent Spring* (Carson, Darling, and Darling 1962) and *Small is Beautiful (Schumacher 1973)* or the more recent *Earth Logic* report (Fletcher and Tham 2019) are not currently being stimulated in EU policy.

Heikkilä et. al, (2018) propose that a CE builds on a user-led and eco-systemic partnership model consisting of many stakeholders that together uphold resources at the highest possible level by stimulating long use phases, resale, services for maintenance, mending and repair, and various textile technologies for repurposing. As the EU textile strategy suggests, such a system would have long-lived and high quality textiles as its prime medium for it to work. Looking back in history there are many examples of what might be understood as circular economies, as for example the 18th-and 19th Century Japanese Boro culture where textiles were so heavily regulated that even smaller scraps of used textiles generated a high value, and therefore needed to perform well throughout all its possible lives (Price and Tebelius 2021).

As this conference addresses 'product lifetime and the environment', an important question we need to ask is how terms such as 'high quality' and 'long-lived' are defined and assessed, and what type of data would be needed to underpin them. We here follow the concept of 'technical longevity' defined by Hasling and Ræbild (2017) that focus on technical properties of fibers such as tensile strength. While there is a growing scholarly debate on how to build data for promoting longevity in the use phase (see, for example Wiedemann et al. (2020), this paper will highlight how a comprehensive body of data, primarily from agriculture, is missing from textiles LCA assessment schemes and are also not included in textile assessment schemes and certifications. This is important, as it is estimated that 31% of all textiles derive from agriculture (Textile Exhange 2022). Through qualitative interviews with 8 leading sustainability consultancies in Denmark, we have investigated what this has of consequences for the way these assessments guide industry, and what effects this might have on longevity and quality of textiles.

Methodology

For the literature study of agricultural production methods, sustainable practices and agricultural LCA methods, as well as assessment criteria for the most widely used certification schemes, cited literature within was found using Web of Science and reports available online. Insights into data availability and LCA model functioning was supplied by Ecoinvent (World Food LCA Database 2017; Nemecek and Schnetze 2011).

Informed by these issues seven semi-structured qualitative interviews were conducted May-October 2021 with Danish gatekeepers of sustainable sourcing of textiles; Respondents were sourced through

snowballing within the Danish network of fellow researchers, trade organizations, and innovation networks. Six of these are consultants who work in leading Danish sustainability agencies- and organizations. The 7th interview is conducted with a Danish representative of the European Environment Agency who is actively engaged with developing and implementing EU directives in the area of textiles. Interviews were recorded on Zoom on the basis of remote HCI research methods and transcribed subsequently (MacLeod et al. 2017). Permission was provided to record all interviews on the condition that all statements were made anonymous.

Interviews were semi-structured and built on laddered dialogue, or what Kvale and Brinkman have named 'conversation as research' (Kvale and Brinkmann 2015). All interviews were opened with more informative questions where respondents presented themselves and their agency/organization. Selected themes for the second sequence were 1) how do they work with risk assessment in the production chain, and where do they place particular focus, preferably visualized (respondents displayed PowerPoints from their presentation material, or would draw the production chain on a paper and show on the screen), 2) plant fiber production - what parameters are included in their risk assessments i.e. carbon capture, biodiversity losses, soil management etc.

The third sequence worked as a summation of the issues discussed. In the following order, questions were 1) what are the biggest issues or risks with regards to plant fiber production and sustainability consultancy (respondents were provided with a line of possible areas such as transparency, resources/cost, qualifications, regulation etc.). 2) what types of knowledge would be beneficial for them to have collected, as a way of assessing the development of the parameters discussed, 3) what types of systemic barriers they see as main focus areas of future research in sustainability and textiles, with particular impetus on plant fiber production.

Subsequently, the empirical data was interpolated up against the parameters of leading textile assessment schemes, as well as data from the literature study.

Impact assessments; Between agroecology and textiles certification schemes

Textile industries rely on certifications or life cycle analysis (LCA) to monitor and evaluate their environmental footprint. The certifications, however, do not address the complexity of agricultural sustainability beyond the dichotomy between organic and conventional systems.
LCAs pull data from a range of life cycle inventory (LCI) databases, such as Ecoinvent and The Environmental Footprint (EF) database on the environmental impact of a wide array of products, services and processes. LCA's are the basis for the publicly available Higg Material Sustainability Index (MSI) and The Product Environmental Footprint (PEF) – which is the EU's method of calculating a product's environmental footprint (Sandin, Roos, and Johansson 2019).

The processes which can be modelled in LCA are ozone depletion, acidification, freshwater eutrophication, marine eutrophication, human toxicity, photochemical oxidant formation, particulate matter formation, terrestrial eco-toxicity, freshwater eco-toxicity, marine eco-toxicity, ionizing radiation, urban land use, and fossil energy consumption (Fan et al. 2022). However, some key aspects of sustainable agriculture, such as better soil health and biodiversity, are largely ignored in current LCA methods (Sandin, Roos, and Johansson 2019).

Several papers have revealed issues within the current use of LCA's as the main tool used to account for sustainability in plant fiber production and thereby textiles (Fan et al. 2022; Wiedemann et al. 2020; Watson and Wiedemann 2019; van der Velden, Patel, and

Vogtlander 2014; Sandin, Roos, and Johansson 2019; Roos et al. 2016). The models used often a) generate data which don't account for spatio-temporal differences which are particularly evident in fiber production systems and third scope impacts, b) evaluate a limited range of impact categories which do not account biodiversity losses and ecosystem functioning (Fan et al. 2022), c) there is more validated data available for some processes than others, some are completely missing, d) there is generally no or little information about the uncertainty of data (Sandin, Roos, and Johansson 2019), e) there are transparency issues as many of the datasets in life cycle inventory databases are protected behind a payment wall and not accessible to the scientific community. Therefore, more research is needed to include more operational indicators and a broader perspective of agricultural multi-functionality towards a better representation of plant fiber production than is currently the case in LCA methodologies.

Another method textile sourcers use to estimate the environmental impact of a textile is by using textile certifications. Some certification schemes are very specialized in a particular area of the textile supply-chain. For instance, the SA8000 certification covers labor rights in manufacturing processes ("SA8000 Certified Organizations - SAI" 2021), while other certifications (i.e. B-corp) cover more parameters and processes (B-corps 2021). Some certification schemes seek to monitor and validate sustainable agronomic practices. Only one certification scheme (ROC) monitors agricultural production practices beyond the organic vs. conventional dichotomy. Codex Alimentarius Guidelines and IFOAM Basic Standards provide a minimum baseline for national and regional organic production standards worldwide, but required management practices differ greatly according to national organic standards and are not required to obtain GOTS and Swan label certifications (Varin and Guzmán 2019). For instance, 41% of organic cotton farmers in India use reduced tillage in their soil management, in comparison with only 17 % in African countries (Textile Exchange 2021).

Lastly, and perhaps most important to definitions of technical longevity of fibers, agricultural cultural practices and growth conditions can not only have immediate detrimental effects on ground, - and surface water quality, soil health, biodiversity and carbon emissions, but they also affect fiber quality. Tenacity, length, length uniformity, short fiber content and fineness of constituent cotton fibers are all influenced by soil and crop management (Bednarz et al. 2004; Majumdar 2011). For instance, reduced soil disturbance (i.e. tilling) increases the organic matter fraction in the topsoil layer thereby both sequestering carbon and increasing the soils water holding capacity. It has previously been shown that water-stressed plants produce fibers with reduced length and uniformity. Therefore, reducing soil management such as it is done in regenerative agriculture might have a positive effect on fiber quality, thereby increasing the longevity of the finished product. Taking fiber quality into account when estimating the environmental footprint of agronomic practices could potentially affect how these practices 'score' when evaluated, for instance in an LCA. None the less, no papers linking agricultural sustainability and fiber quality could be found (Islam, Perry, and Gill 2020).

As such, it can be concluded that current assessment schemes for textiles such as LCAs and certifications do not take into consideration the huge negative environmental impact that natural fiber feedstock production has on soil, biodiversity, and other very important climatic parameters. Neither are vital parameters for the quality of fibers deriving from soil and growing conditions included. In the following, we will showcase what effect this has on industry practices today in the local site of Denmark, based on empirical data from leading sustainability consultancies.

Table 1. Interviews with sustainable textile advisors.

	Advising	Advising on	Evaluation method	Agronomic background	Systemic issues
Consultant A	Small and medium sized fashion companies	Design processes Risk management Certifications Choice/variety of materials	Certifications Gut feeling. Fiber level comparisons	No	Need for agronomic data Outsourcing conflict Size and width of collections
Consultant B	Small and medium sized fashion companies	Design Processes Risk assessment Fibers Certifications Social compliance Packaging materials	Certifications Gut feeling Fiber level comparisons	No	Need for agronomic data Trading system of fibers Lack of regulation Outsourcing No easy-to-understand guidelines More certifications
Consultant C	Small and medium sized fashion and design companies	Design Processes Risk assessment fibers Certifications Social compliance Packaging materials Recycling potential	LCA's Certifications Gut feeling Fiber level comparisons	No	More regulation Tools to help guide suppliers on improvement on a range of parameters. More advanced certifications.
Consultant D	Design companies	Risk assessment Circular business development.	Material from suppliers LCA's	No	Need for support from research institutions International regulation
Consultant E	Trade organization Textile industry	EU-law, labor rights, chemicals, environmental footprint.	Material from suppliers, certifications, gut feeling, fiber level comparison	No	Lack of data and guidelines International regulation and support from research community

Industry practices; a qualitative dive

The interviews highlighted both structural issues and surprisingly large knowledge gaps when dealing with risk assessment in agricultural systems (Table 1). With no educational or practical background in evaluating agroecosystem sustainability parameters and their influence on price and quality, consultants relied heavily on the evaluations provided by a range of certification systems.

All respondents were surprised to learn that organic cotton production was a national standard and that requirements were not established by GOTS but vary between countries. Furthermore, while some respondents were aware that organic cotton production does not address several important issues in fiber production (i.e., carbon sequestration), they were unsure about what parameters to monitor, how to monitor them, and how to set goals for improvement. Three respondents frequently advised clients to limit the number of different textiles used in collections and to limit the number of styles per collection. One respondent relied mostly on LCA analysis for recommendations on fiber sourcing. While realizing that the scope of LCAs were limited and that the underlying data may or may not be correct and up to date it was simply "the only tool available".

Realizing that they do not have the size and expertise to conduct field experiments themselves, several respondents expressed a need for validated data and guidelines be produced and developed by research institutions.

Discussion, Conclusions and further Perspectives

The interviews reveal that many of the production choices which are made in plant fiber production are not clear to designers and sourcers. Instead, textile industries rely on LCA's or certifications like GOTS, OEKO-Tex, and B-Corp to monitor and evaluate their environmental footprint. Neither LCA's or

certifications, however, address the complexity of agricultural sustainability beyond the dichotomy between organic and conventional systems. More and updated data on several impact categories is needed along with more sophisticated models and regulation of best practices in order to increase agricultural sustainability in plant fiber production.

This study looked at plant-based fiber feedstock for textiles that represents 31% of all textiles production today. It reviewed LCA measurement methods from eco-agriculture up against current LCA's on textiles, textiles certification schemes, and best practice for guiding industry showcased by interviews with local gatekeepers in Denmark. The study revealed that the LCA schemes that currently underpin the environmental assessment behind the EU textile strategy is not compatible with planetary boundaries, as they do not take into consideration the situated and contextual interconnection between soil, climate, and fiber. If they did, assessments and indeed future EU regulation would point towards a CE defined by Bauwens et al as *bottom-up sufficiency (Bauwens, Hekkert, and Kirchherr 2020)*in which de-centralised, locally based and small-scale production would support local needs rather than feed into the existing linear growth economy. Going forward, assessment schemes are needed which can inform more systemically, and for example take into consideration how to limit the scale and volume of the resource uptake of raw materials by the industry of today. Furthermore, neither LCA's nor certification schemes on textiles currently take into consideration urgent agricultural parameters that effect fiber performance – and as such – what needs to be assessed if we indeed are to further 'long-lived' and 'high quality' textiles going forward.

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