



WAGENINGEN
UNIVERSITY & RESEARCH

Programme Sustainable Textiles

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Wageningen Food & Biobased
Research conducts applied research
for sustainable innovations in healthy
food, fresh-food chains and biobased
products.

Executive Summary

This is the first strategic plan for the new Wageningen University and Research (WUR) Programme for Sustainable Textiles. The plan is timely and resulting from the strategic plan of WUR for the period 2018-2023. It is a component of the priority on circular economy, recognizing that textiles are, after food, the second outlet for agricultural produce. If the world needs to be fossil free by 2050, all textiles shall be bio-based and recyclable. Considering the associated impact on land use, water use, biodiversity and incomes for all workers in the value chain, this is a major and persistent challenge. In fact, it is a paradigm shift. WUR feels the duty to be an actor in that transition: to explore the potential of nature to improve the quality of life.

This programme has been written in May-August 2020 by Paulien Harmsen, Dieuwertje de Wagenaar and Michiel Scheffer. It was inspired by more than 50 external stakeholders, and more than 60 researchers at WUR have contributed with their expertise and ambitions.

The programme is thus the consolidation of a broad range of competences in the following institutes:

- WFBR Biobased research: from harvest to functional building blocks, polymers and fibres
- WPR Plant research: genomics, agronomics of fibre crop production
- WLR Livestock research: animal fibres and animal welfare
- WEnR Environmental research: Understanding the dynamics of fibre crops in their environment
- WEcR Economic research: value chain, consumers expectations and policies for sustainable textiles
- WCIDI Development Centre: Implementing transitions in developing countries

The programme is close to the mission of WUR to be a world class institution from fundamental research to application, including an active outreach function with dialogue, debate, initial and lifelong education. In education our priority is to develop online modules based on the successful experience with a massive online open course (MOOC) on circular fashion.

The program has three pillars:

1. Debate, dialogue and dissemination: WUR is a place for open and safe exchange of views and learning
2. Knowledge basis: public and collaborative research with public and private parties and platforms
3. Contract research: research for individual clients within the integrity code of WUR

The programme, as written now, is an invitation for partnership. Our ambition is to link and assist all stakeholders in the transition. Our ambition is also to work in partnerships with complementary Universities and Research of excellence. We are a key partner in the Dutch Circular Textile Valley, and member of the European Technology Platform for Textiles. We aim to set up a partnership with leading institutes in Europe and are also exploring alliances in South- and East-Asia.

Short term priorities are:

- Domain 1 Bio-based fibres from field to fabric, from fabric to fibre
- Domain 2 Water in textile production
- Domain 3 Biodiversity and textiles
- Domain 4 Policies for circular textiles
- Domain 5 Elastane and disruptors of recycling

More detail is to be found in the plan or can be explored in a further (online/offline) meeting with our core team and our specialists.

Wageningen, September 9th 2020

dr. Michiel Scheffer Programme Manager Sustainable Textiles

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1 Introduction

The Sustainable Textiles Programme of Wageningen University and Research aims at systemic change in the textile industry. We define textile as structured fibrous carbon-based/organic chemistry materials (it can also be non-wovens and leather) and includes apparel, household fabrics (upholstery) technical textiles (work clothing). The term sustainability is the warp of the programme. The textile programme is aligned to the overall Circular and Climate-Neutral Programme of WUR.

This first plan for the Sustainable Textiles Programme has two dimensions:

- To federate the different activities inside Wageningen University and Research into one developing identity and to structure interactions with stakeholders in order to maximize societal impact and value with WUR
- To lay the basis for strategic alliances with complementary education and research institutes in order to work on a programmatic way with governments, industry and NGOs on a global level.

This plan essentially covers the first dimension, and supplies input for a separate plan for strategic alliances with complementary partners of excellence. That is also the moment that this programme should be formally presentable to the world.

This plan is the result of an internal exploration inside WUR in order to adhere to the competences and ambitions already unleashed. This exploration has enabled to identify a critical mass of enthusiasm, competences and opportunities. This exploration has been structured by a questionnaire to identify low hanging fruit. Contributions have mainly but not solely come from the institutes: WFBR (Food and Biobased Research), WEcR (Economic research), WPR (Plant-research), WEnR (Environment research) and WCDI (Centre for development innovation).

Simultaneously some 20 interviews with stakeholders have been conducted, especially with global platforms ITMF (International Textiles Manufacturing Federation), IAF (International Apparel Federation), GFA (Global Fashion Agenda) and GFP (Global Fashion Pact).

This plan – in this external form- is not an end point but a starting point for a frank conversation with fellow travellers and the resulting outcome is the basis of programmatic partnerships.

2 Scope

Over the coming decades a transformative shift of the global textile value chain **from a linear to a circular model** is expected to happen, driven by regulatory pressures (e.g. the EU's Green Deal), resource efficiency, cost concerns and consumer demand. Currently, the textile industry is ill prepared for this transformation, lacking robust **circular design and product development** competences, technologies for **efficient recycling** of textile waste (and re-processing of recovered materials into new products) and functioning **circular business models**. Also, common measurements, technical standards, harmonised data generation and information exchange system, as well as robust regulations and public procurement rules, are needed to create a fair level playing field and make the shift from a linear to a circular system technically and economically feasible for all players.

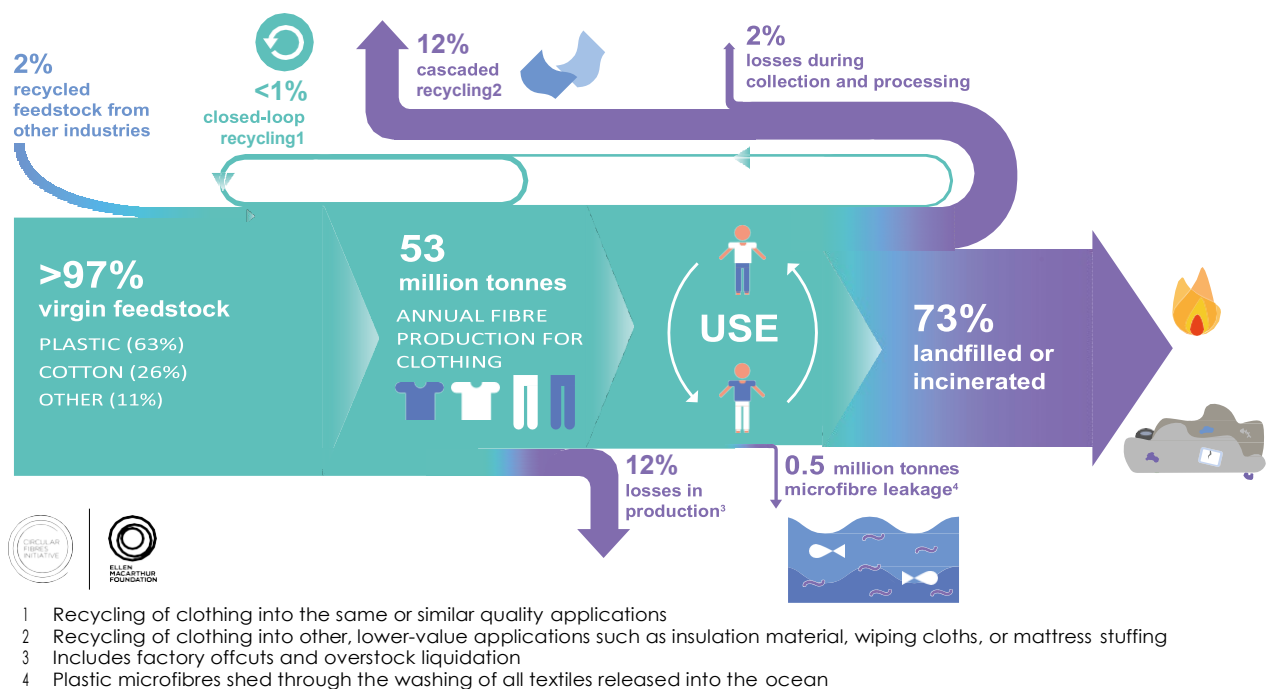


Figure 1: Global material flows for clothing 2015¹

The textile industry is under pressure to demonstrate that its products and production processes are sustainable. A significant role is played by the raw materials (feedstocks/fibres) used and how they are produced and sourced. Currently the EU textile industry depends by over 90% on non-EU sources fibres and feedstocks. Most synthetic fibres, if not directly sourced from outside the EU, are made from non-European fossil feedstocks and most cotton, wool and silk used by the EU textile industry is sourced from outside Europe. For a shift from fossil-based to more renewable, bio-based fibres, the textile industry needs a sound long-term strategy for a safe and cost-effective supply of local bio-based fibres and feedstocks. Many opportunities exist, both in the field of natural fibres through revival of traditional fibre crops (e.g. flax, hemp) or establishment of new ones, in bioprocessing of renewable feedstocks incl. waste from agri- or aquaculture, forestry, food or even CO₂-capture and use.

¹ EllenMacArthurFoundation (2017). A New Textiles Economy: Redesigning fashion's future, Ellen MacArthur Foundation.

3 From linear to circular textiles: Theory of Change

3.1 Introduction

The Sustainable Textiles Programme of Wageningen University & Research aims at systemic change in the textile- and fashion industry, which requires complex interventions. This change can only be reached through collaborative work and partnerships between several disciplines at WUR and with other stakeholders/partners. The ambition of the Sustainable Textiles programme and its cross-sector partnerships, will be based on a Theory of Change (ToC).

A Theory of Change (ToC) is a strategic process to make assumptions about how change happens, in other words, how activities of a programme, project, policy, network or event are expected to contribute to particular results in the short-term and longer-term². In this case, the ToC will be used to design the Sustainable Textiles Programme. In addition, it is aimed at reflecting its ambition and enhancing transformative potential of the programme.

For the ToC to be truly effective, it is required to analyse the context in which the ToC needs to operate. Especially when solving complex problems and multiple partners are involved. Literature research states that "partners can only fully exploit the synergies of working together if they agree on a common vision, mission and objectives"³. In addition, the transformative capacity of the envisioned systemic change by the Sustainable Textiles Programme is determined by the motivation of the partners, the issue addressed, the level of benefit a partnership can achieve for its partners, and the dynamics of the partnering formation process and the chosen partnering configuration². Therefore, it is essential to collectively define objectives and to collaboratively agree on a ToC.

As the goal of the Sustainable Textiles Programme is highly complex, figure 1 presents the requirements for the ToC. A tripartite partnership (civil society, public and private partnerships) is needed, guided not by linear action plans, but by triple loop learning. A process of continuous evaluation and improving strategy². Below, the design- and learning components are listed, that the ToC should contain, developed in collaboration with the partners.

In collaboration with the identified partners, sessions will be organized to engage in a dialogue to define all necessary steps of ToC development, whilst keeping in mind the complexity alignment framework for cross-sectoral partnerships, in order to maximize the ownership and alignment of partners in the Sustainable Textiles Programme.

The outcome of these sessions will be a defined ToC, resulting in a collaborative vision, strategy, indicators for measuring change and evaluation, and lastly a visual representation of the ToC. Therefore, this chapter is the first draft of collaborative work towards a ToC.

² Van Es, M., Guijt, I., and Vogel, I. (2015) *Hivos ToC Guidelines: Theory of Change Thinking in Practice - A Stepwise Approach*, Hivos, The Hague. Available from: <http://tinyurl.com/hr53xh2>

³ Van Tulder, R., & Keen, N. (2018) *Capturing Collaborative Challenges: Designing Complexity-Sensitive Theories of Change for Cross-Sector Partnerships*. In *Journal of Business Ethics*. Available from: <https://doi.org/10.1007/s10551-018-3857-7>

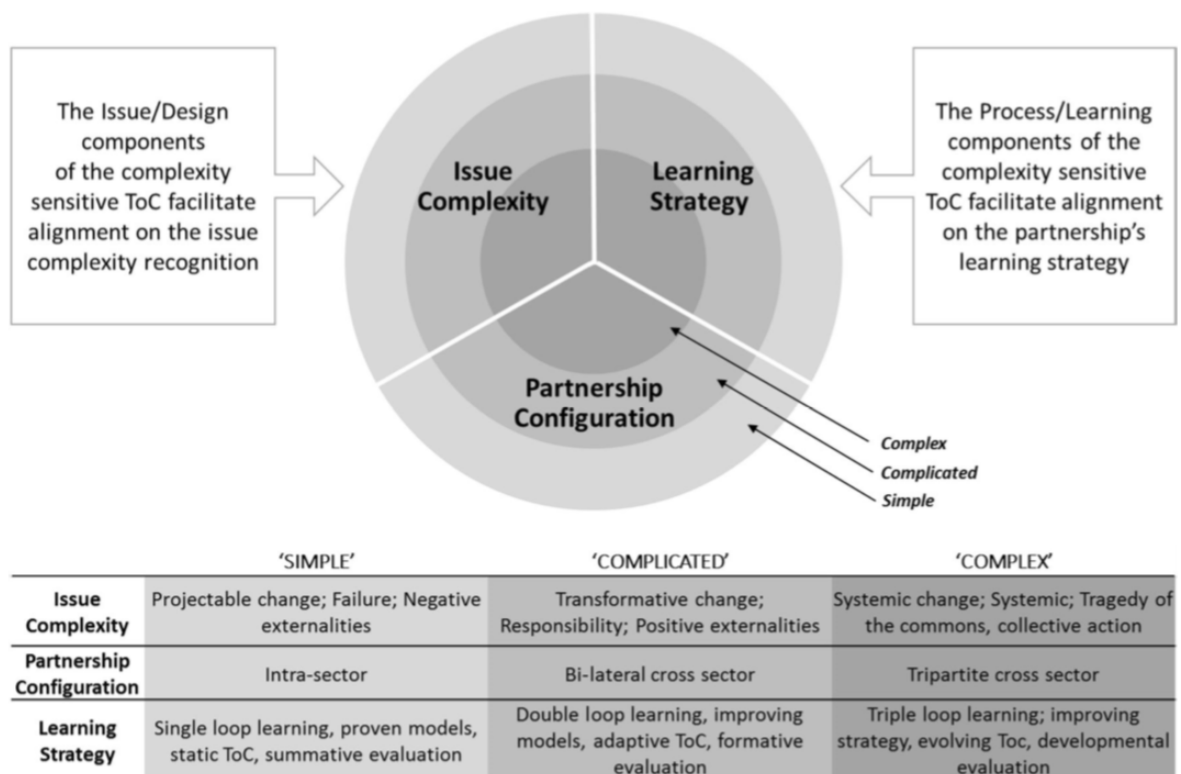


Figure 2: Complexity alignment framework for Cross-Sector Partnerships. Source (van Tulder & Keen, 2018).

3.2 Domains of Change

Circularity is considered essential to improve the sustainability of the textile industry. It is a concept that originates from the field of industrial ecology, combined with circular design concepts such as cradle to cradle. The underlying concerns are the ever-increasing depletion of non-renewable feedstock⁴. Circular solutions thus aim at fulfilling societal demand while minimizing the input of virgin resources and form the base of the Sustainable Textiles Programme. Work is needed to identify, research and implement more sustainable production, higher resource use efficiency, improved working conditions, consumer behaviour and reduced overall environmental impact. In this paragraph the five core themes of the programme will be introduced.

3.2.1 Consumer behaviour

The first step towards circularity is refusing the use of resources and consumption, ideally preventing the generation of waste. From consumption patterns of shopping behaviour, to use, washing and discarding fashion and textiles, in the fashion industry, the consumer/user is a key player.

Investigating increased clothing wear for example through implementing circular business models, textile rental, second-hand and vintage retail is required to gain understanding of wardrobe maintenance and management. This is aimed at identifying levers for change for reducing clothing volumes.

3.2.2 Design

Design characterizes the start of the fashion value chain, any decisions made in the design phase will result in consequences for production, use and end-of-life. Therefore, design is a crucial step in the transition towards circularity. Textiles and garments extend further than functional meaning in the form of protection, in addition it has a symbolic meaning, cultural context, personal identity and aesthetic meaning. Therefore, design extends from technical challenges to personal, and consumerist challenges.

⁴ Harmsen, P. F. H. and H. L. Bos (2020). Textile for circular fashion. Part 1: Fibre resources and recycling options. Wageningen, Wageningen University & Research, <https://edepot.wur.nl/517183>

Current design practices are focused on the aesthetic experience, rather than sustainable or circular guidelines, such as extended use (longevity) or recycling. The core theme Design is aimed at rethinking current practices and serve more holistic views of textiles in identity, function and consequence.

3.2.3 Resources

In 2018, global fibre production was around 107 million ton. Fibre production has more than doubled in the last 20 years and is expected to reach 145 million ton in 2030 if business as usual continues. Over the last decades, the textile industry has experienced a transition from using biobased feedstocks (wool, cotton, flax) to more fossil-based alternatives (mainly polyester PET). Looking at the current production volumes of textile fibres, fossil-based synthetic fibres are by far the largest (65%), followed by vegetable fibres (30%) and regenerated fibres (5%). In addition, the increasing complexity of the fabric composition (blended fabrics) has had a detrimental impact on the recyclability of textile products.

The core theme Resources focuses on reducing the use of virgin feedstock. This challenge is major, as currently 65% of the fibre mix is from fossil resources (corresponding to 70 Mton that needs to be replaced) For the transition from fossil to renewable feedstock, production of fibre crops needs to be increased and use of alternative feedstocks from agricultural crops and residues should be encouraged.

Within the class of biobased fibres, we distinguish 3 main classes: **vegetable fibres**, **regenerated cellulose fibres** and **synthetic fibres**, mainly based on cellulose and/or sugar (see figure below). This figure illustrates the complexity of the system, as each fibre type requires different biomass resources and processing. In addition, there is a differentiation between staple fibres and filaments as fibre products, and critical biomass parameters are different for each type of fibre.

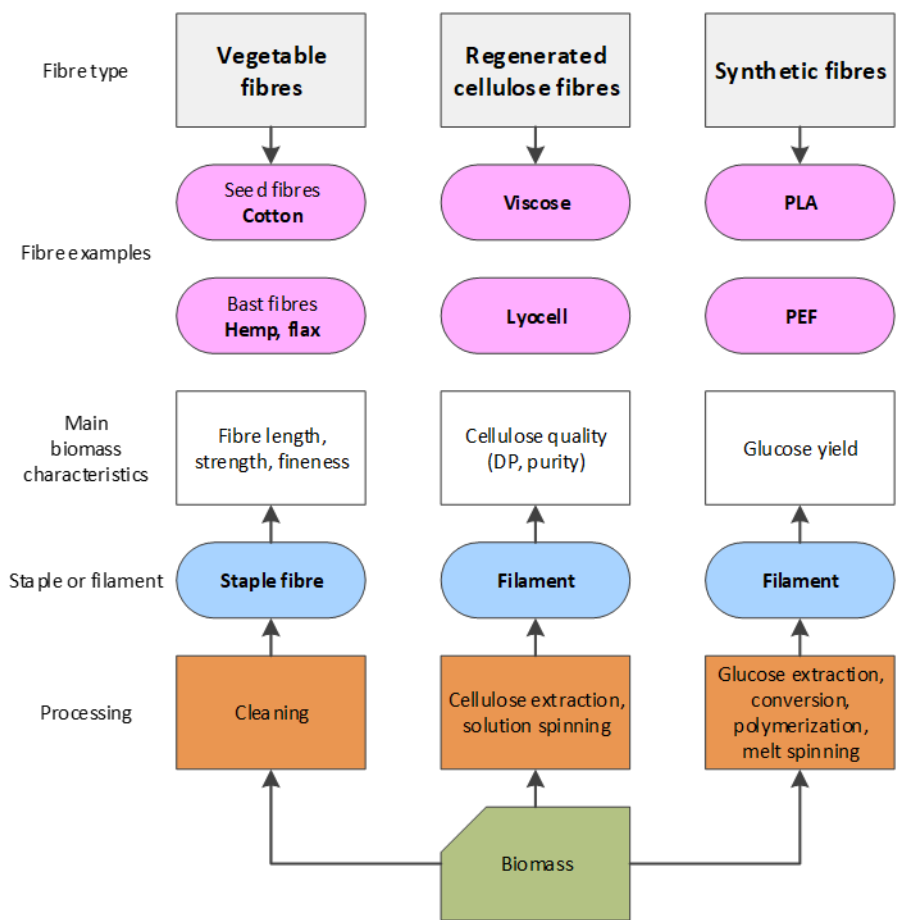


Figure 3: relation between 3 main fibre classes and the production routes from renewable resources. (PLA= polylactic acid, PEF= polyethylene furanoate, both polyesters)

What this figure also illustrates are the large differences in maintaining the fibre structure coupled to complexity of processing. Vegetable fibres have the highest degree of maintaining the natural fibre structure and processing is limited. For synthetic fibres, the biomass structure is fully broken down to glucose moieties and new polymers need to be built up again by polymerization of the specific building blocks. As a result, processing consists of many steps. Regenerated fibres are in between, as the structure of the biomass fibres is changed, but the cellulosic polymers that make up the fibre remain intact.

3.2.4 *End-of-Life*

When a garment is disposed of, ideally it is first reused by another customer through the second-hand or vintage market. When the garment is no longer suitable for reuse, it can be downcycled into a product of lower value such as wiping rags. When the fabric is no longer usable as such, fibre recycling techniques come into play. And when fibre recycling is also no longer possible, energetic recovery (burning with energy recovery), or, worse, landfilling are currently the final options. Recycling technologies that are being developed now are mainly suitable for monomaterials like 100% cotton or 100% PET, while post-consumer textiles are mainly composed of blended materials. In this case, recycling becomes technically complicated, energy consuming and expensive.

Ambitions for the use of recycled content are high, but fact is that textile recycling (and especially post-consumer waste to new textile fibres) is still in its infancy and available volumes of recycled content are low. This will be a major challenge for the coming years for the following reasons:

- Recycling of fabrics is limited to cellulose-based materials to wiping rags
- Recycling of fibres by mechanical means, is only suitable for natural fibres like cotton and wool, and probably also for polyacrylics. In the case of wool, the fibres can be re-spun into yarns for the production of knitwear, whereas for cotton the fibres often end-up in applications other than textiles.
- For the recycling of polymers, the options are as follows:
 - o Cellulose-based polymers (cotton, viscose, linen) can be recycled by the viscose process or lyocell process, where the cellulose is dissolved and re-spun to a new fibre, suitable for textile applications. Input for these processes is a dissolving cellulose pulp, containing >90% cellulose.
 - o Synthetic fibres (polyesters, polyamides) can be recycled by melting the material at high temperature and re-spinning to fibres. Input for these processes needs to be highly purified material.
- For the recycling of monomers only polyesters and polyamides are suitable. Input for these processes can be less pure material, although for repolymerisation the monomers need to be 100% pure.

3.2.5 *Value chain*

The value chain of the textile and fashion industry is large, complex and often challenging. The long-standing history of food value chain research with proven analytical methods at Wageningen University & Research, provides ample opportunity to address issues in the textiles and fashion value chain. The transition from linear textiles to circular textiles, and the complete transition from fossil-based to renewable-based of the textile industry is a complex and long-term transition, akin an industrial revolution.

In order to transition to a more circular industry, several interventions are considered requiring collaboration throughout the entire value chain. These are potential areas of policy analysis and design in which WUR can contribute. For example, new regulations and levies on CO₂ emissions, water use, soil contaminants, higher prices and revenues for farmers, changes in product safety rules, incentives in products using textiles, but also rules on recycled content and instruments like extended producer responsibility. The challenge is the implementation of sustainable innovation in a fragmented, complex and international value chain.

That demands for long term research and implementation plans and as the market is fragmented, a long term programmatic commitment of local, national and international government.

3.3 Challenges

3.3.1 Sustainable Development Goals (SDG's) are too generic to be easily applicable

The SDG's are a basis to develop sustainability action plans, such as done by GFA and GFP. Older generation plans have developed iteratively, but when they moved from social conditions of labour into environmental conditions their base became weaker and implementation more difficult. More practical are national action plans (e.g. in NL, FR) or European directives such as on REACH (Registration, Evaluation, Authorization and restriction of Chemicals) and BAT (Best Available Technologies), but the latter lack a comprehensive approach, even if integrated as in the Netherlands in MJA's (Meerjarenaafspraken Energie). A challenge is thus to help the different stages of the industry to have their action plans that are aligned to each other.

3.3.2 Knowledge basis is not standardised

The basis to work with is not standardised. The International Labour Organisation (ILO) conventions have become the accepted base for labour standards, but for environmental standards there is no common knowledge basis, no common standards, no milestones for improvement. Moreover, for lack of public (democratically acknowledged) standards, a multiplication of private standards has developed, much to the confusion of SMEs and consumers. The lack of involvement of stakeholders leads to a constant debate on norms. For example, LCA's are often based on historical data, while water, fertilizers and pesticides used in cotton cultivation changes every year. Moreover, LCA do not integrate durability of products or their recyclability. This leads to demands of evaluating all dimensions of standards: from their design, their auditing, and their impact on choices of farmers, manufacturers, designers and consumers.

3.3.3 Fragmented industry with weak and fragmented governance

The textile industry is a very fragmented industry. In the EU alone, there are more than 200.000 companies involved in designing, manufacturing and retailing fashion. The world has more than 7 million farmers engaged in cotton cultivation. The largest retailer only buys 1% of world's cotton production. The industry has numerous associations, with some global umbrella organisations but with limited manpower and almost no legal competences. The industry, from cultivation till designing is spread over 50 countries, and multilateral organisations are weak, and textiles is spread over at least 5 UN Agencies. The strongest power is the EU, as the largest single market for textiles and the second largest industry in the world.

Also, education and research are scattered over more than 200 with only a handful with sizeable size and capacities. No single one can be leading, hence strategic alliances are needed amongst universities, but also aligned to governments and industry. The Netherlands has reasonably good conditions as a hub of a triple helix.

3.3.4 Sustainability and business drivers are not fully aligned

Sustainability has been a topic in textile industry since the 1970s but with a strong focus on water and air pollution. Gone are the days, in Europe, that rivers disclosed next season fashion colours. The textile industry has already experience with energy reduction, water recovery and the search for alternative production methods (CO₂ dyeing, digital printing). Awareness of more fundamental problems only arose in the 1990s, but action started only this century. Biopolymers have, albeit hesitantly, come to the market, certificates have been developed, global platforms have formed. But the massive outsourcing of production and the emergence of fast fashion is also a feature of this century, boosted by liberalisation of trade. The pattern of process is imbalanced, especially as long as sustainability is not fully integrated in industry practices still dominated by fashion imperatives, pressure on prices and delivery times.

3.3.5 Framework conditions are not optimal, and governance philosophies are naïve

The textile industry is a highly fragmented industry, and a global one with a complex value chain. It is an industry with an almost pure free market with a dominant price logic. Cotton has now the same price as in 1970, the price of polyester is now less than 50% of the 1970 price. The low prices of virgin materials hardly remunerate farmers in a decent way, do not discount for the environmental impact of fibre production and hamper a level playing field for novel biobased fibres or for regenerated fibres. Policy initiatives have been between experimental and hesitant, as yet refraining from measures and regulations that fundamentally would create a level playing field for recycling or fibres with a lower footprint. Much room has been given to private initiatives that lack massive adhesion, a strong governance or substantial means. However, there is no alternative than to move on, and while more fundamental tools are being discussed and considered, there is certainly demand for a strong knowledge basis. However the COVID-19 crisis may lead to speeding up and scaling up of policies.

4 The WUR proposition

4.1 WUR philosophy

Be a thought leader

Wageningen University and Research has been for a century a thought leader and motor for a strong agriculture and food security. For textiles and sustainability WUR should play a similar role. Textiles is a major industry and sustainable challenges should be seen in an overall context, since land and water use are a major issue. The value chain is complex and requires a moderator to bring parties together. It is a major transition challenging dominant concepts and practices.

Be critical, but beyond judging: assist

Sustainability is an endeavour and often an iterative process. It impacts governance of organisations, it implies writing of off assets, changes properties of materials, behaviour buyers, procedures in manufacturing. WUR is on the side of those who recognize the dilemmas, develop strategies, acknowledge barriers and try to overcome it. We are aware of a phenomenon called greenwashing; we are rather aware of the shortcomings of human nature. Hence our approach is to analyse sharply, recognize the barriers and help those with a genuine will to overcome them. We bring together and assist players with genuine intentions.

Make big challenges feasible

Change is feasible by segmenting the road ahead in feasible steps and visible milestones. Sometimes a careful exploration of alternatives is required before moving forwards. As a University we are partners in that exploration. The objective is to improve but also evaluate the pitfalls and the downsides. Challenges become feasible by recognizing them, sometimes by harvesting low hanging fruit, but also by investing in time in addressing them fully. However, analysis should never be an excuse for paralysis, we are also a laboratory to test and try to the circular fashion community.

Create a common language and shared understanding

From field to fashion or from polymer to piping the textile chain speaks a different language. For a linen farmer, a weave designer or a pattern maker the term "grading" has a different meaning. Even a fibre has a different magnitude for a chemist, a textile engineer or a retail buyer. The world of textile speaks more than 100 languages, with bad English as the most commonly spoken. The textile world has a few PhD's and still many illiterates. Hence there is a need to create a common language, or at least a shared understanding of each other's language. This language is not only written but look-and-feel is essential for inspiration and validation of materials. The wide field of expertise of WUR enables us to speak the language of many, but we also have first a challenge to understand each other, before being able to a place of meeting for others.

Support platforms with shared objectives

WUR has a track record of promoting collective concertation and action. We do that with innovators in protein transition and in training of subsistence farmers in India. This approach of organising articulation of questions and creating critical mass by creating and supporting platforms of operators with similar interests or values, shall be applied to textiles, but adjusted to the specific questions at stake. The idea is always to bring first movers together that want change things, but always understanding the field of stakeholders and always with open access, and with consideration for players with a weaker voice.

Help first movers to go ahead, and second movers to make feasible steps

WUR is available in contract research for the pioneers and the followers. First movers and second movers both have their challenges, merits and demands. WUR adheres to high principles of authority, integrity and confidentiality. We clearly distinguish access rights to collective research and protection of rights gained in one-to-one contract research. We strive at optimal protection of confidentiality. However, we do strive at giving an honest price and value proposition to each account. We are a public funded

organisation, with substantial industrial activities. We are not for profit, but our commercial margins on contract research enables us to invest in people, facilities and knowledge.

Train a new generation of talents, trainers and lifelong learning towards sustainability

WUR is a unique education facility, over the last decade the best in the Netherlands, and worldwide the top in life-sciences. Our 12000 students come from more than 100 countries, making the Campus a global meeting place, with life-long lasting connections. Our commitment is to engage new talents into the challenge of sustainability but also to translate our knowledge and experience to lifelong learning and across vocational and professional training. Research should also enrich education, and education enables talent to get acquainted to research. Besides doing that on the Campus we want it be online and offline a laboratory of lifelong learning.

Work across the Technology Readiness Levels

WUR is a unique institution as its "R" component is an applied research centre with 2400 researchers and an international outlook. As a research centre it is also the formal TO2 Institute for the Ministry of Agriculture in the Netherlands and a key partner for other ministries and for international organisations. The Campus is more than a University site but also the location of R&D centres like Unilever. Hence, we are also an institution that works from fundamental knowledge (TRL1) till practical applications in the field (TRL9). The sustainable textile programme shall structure that funnel internally and be accessible to a broad range of questions at each TRL stage.

Interact across triple helix

WUR is used to work across the triple helix: with other research and education institutes, with farmers and industry and with public authorities. We work from local, e.g. in our Food Valley Region to global in alliances to global with a presence in countries like India and China. Of course, Europe is our home and we are committed to the assist achieving the policy objectives of European Union. Wageningen is sometimes called "the Silicon Valley for Food", but our strength is more than attracting talent to this small Dutch city, but by connecting to complementary skills and insights.

4.2 WUR proposition

The concrete proposition of WUR is starting from the core missions of WUR as defined and confirmed in its strategic plan. Thematically it is aligned to the circular programme and will optimize the interfaces to get off, e.g. in the current KB project and the planned conference end of 2021. The textile programme is therefore a broad programme to be rooted in the University and the Research Centres. The three pillars are built around three missions:

Pillar 1 To be a place of dialogue, debate, encounter and inspiration

Pillar 2 To provide a knowledge base enabling a long-term transition

Pillar 3 To be a partner in concrete research, innovation and policy

The three pillars also reflect that some players in the industry (described in section 5.1) are ready to engage in concrete and customized research, whereas for others sensibilisation is still needed.

4.2.1 Pillar 1: Debate, Dialogue, Dissemination

4.2.1.1 Introduction

The first strand is to develop further WUR as a place of debate, interaction and dissemination in relation to sustainable textiles. The ambition is twofold: first to be a place of reference for an academically inspired debate on textile and sustainability. The approach of WUR is to be a critical friend: taking genuine ambitions as a starting point for an inquiry and search. Second, the ambition of WUR is to teach and inspire: to be a place to inspire people on textile and sustainability and to foster a culture of sustained action. By having an interaction and debate function professionals are being trained to be aware of sustainability issues.

There is a clear connection with the education side of WUR (1ste geldstroom) and with curiosity driven research (2de geldstroom).

In terms of education, the priority for 2020/22 is to develop existing activities such as the MOOC (Massive Open Online Course), projects of the ACT (Academic Consultancy Training) and Science Shop, and to offer courses in the curriculum. The MOOC's, as well as the first book on textile recycling⁴ is a basis to develop and disseminate. The development of more elaborated education programmes should be studied by looking at the offer existing at HBO and WO level with an outreach of 500 km from WUR. Besides this, an offer of contract education will be examined.

In terms of curiosity driven research, the approach is to set up a contact group of the programme with key chairs of the University, and to examine ambitions and opportunities. For the programme itself the approach is threefold: support research proposals (NWA, NWO, Horizon etc...) that enable strengthening of the knowledge basis; projects strengthening relations with key academic and research partners; facilitate relations with industry. The latter implies partner search, assistance in partnership management and support in dissemination activities.

4.2.1.2 Services

This strand is to be developed in four services:

Circular Fashion Lab®

The Circular Fashion Lab is both a broad term covering reaching out activities of WUR, and a narrower term covering demonstration activities of WUR in sustainable textiles as done at Dutch Design Week and at State of Fashion. The lab formula is to invite designers to use circular and sustainable materials, develop products and show them to a wider public. The Lab plays into the need of designers, buyers and consumers that are inspired and challenged by the look-and-feel experience of sustainable materials. The Lab brings together actors but should also be a standard feature involved in dissemination plans of projects. Our Chairman of the CvB is in her personal choices the ambassador of the Lab. Participation in DDW 2020 is already on the agenda. Participation in the 2022 State of Fashion is currently explored.

Interaction sessions

Dialogue sessions last between an evening and a full day and aim at covering a topic with an invited audience with the aim to generate ideas, understanding and possibly an action plan or project. The dialogue sessions are conducted on a "Chatham Rule" basis in order to enable a frank exchange of views. WUR acts as a honest broker, a safe place of exchange and a seed-bed for action. Dialogue sessions are conducted on a cost covering basis.

Possible themes for 2020/21: Cascading waste, Rental models for fashion, Improving the basis for LCA, Implementing Biodiversity...

Wageningen-Action Programme

The concept is to organize an annual conference on textile sustainability. This can be stand-alone or in alliance with RWTH Aachen and IFM Paris. The conference is to be a cornerstone of a process involving a preparation and an outreach after the event. The event could be like a "big bazaar", with core events, fringe meetings, dissemination sessions of projects and possibly elements of a trade fair and dialogue sessions. To maximize audience and control costs and risks the organization could be in co-production with partners (e.g. Modint, Federatie Textielverzorging Nederland).

The concept is to combine the event with an annual progress report on sustainability in textiles. The progress report is a reflection on the work done at WUR, with partners and in key initiatives

MOOC

One of the most tangible results from Circular Fashion Lab® 2019/2020 has been the development of the Massive Open Online Course, Circular Fashion: Design, Science and Value in a Sustainable Clothing Industry. Within six months the course has attracted over ten thousand learners worldwide. The purpose of MOOCs is not only to provide education and thought leadership on textiles and fashion, at the same

time it gains insight into among others consumer behaviour and therewith provides important data from learners that can be used for research opportunities at WUR.

Currently, three other MOOCs on sustainable fashion have been developed (by Kering/Londen College of Fashion, Fashion Revolution and Sustainable Business School Copenhagen). Therefore, the aim is to expand the course content by 2021, to strengthen WUR as an important institute for education and research on sustainable textile and fashion. Themes that can be further explored are resource and material innovation, circular design, consumer behaviour and more.

Sustainable Textile Technologies-Industrial Group

Wageningen, but also possible partners as RWTH (Rheinisch-Westfälische Technische Hochschule in Aachen, and IFM (Institut Français de la Mode in Paris), have experience in organizing groups of companies around their education and research activities. In Wageningen, the Club van 100 – federating technology suppliers in the horticulture industry is an inspiring experience (understanding that the name Clubvan100 is protected). At the moment WUR, RWTH and IFM each have their core supporters resp. biopolymers, technical textiles and textile technology and luxury groups. Initial research shows mainly an interest to bring together technology suppliers to the textile value chain (enzymatic processes, digital printing, CO₂ dyeing, ICT). Initially the idea is to create an informal group of stakeholders, first to validate this plan, then to develop a more specific approach.

4.2.2 Pillar 2: Knowledge basis

4.2.2.1 Introduction

The second strand is to develop a knowledge basis. The concept of a knowledge basis is longitudinal research and steady knowledge development in core programmes. It is partly rooted in established capabilities, to be enriched by transferable skills (leveraging agro/food research capabilities to fibres/textiles). It shall need to be enriched by road mapping exercises with industrial partners.

There is clear interest in structuring knowledge on natural fibres. The main natural fibres are cotton and the feedstock for viscose and biopolymers. Of smaller interest are wool, linen and hemp. Leather, strictly speaking not a fibre, is an important material in the fashion and furniture industry and is a waste product from agriculture. There is a strong demand for standardized methods of cultivation, harvesting, grading and processing in order to better meet demands in the market on quantity and quality. For biopolymers feedstock analysis and development of cultivation basins is required.

There is also interest in more knowledge on the workings of the value chain regarding the following aspects:

- The agriculture of fibre crops in their “natural” context with regard to impact on water/soil quality and biodiversity. Related to this, members of platforms such as Global Fashion Agenda (GFA) and Global Fashion Pact (GFP) strive to translate biodiversity in effective action plans. For many fibres, especially cotton LCA’s have to be rooted in an actual and specific database by cultivation basin.
- As highlighted by a recent article in Harvard Business Review⁵ there is an urgent debate needed on manufacturing strategies in the textile and fashion industry, since attaining sustainability demands better alignment or even integration in the supply chain. The debate develops on the seminal work of Scheffer (1992)⁶ on subcontracting in the clothing industry. More operationally: much sustainability results can be obtained by more effective customer response in the entire supply chain.
- Since recycling should fill a growing part of global fibre demand, two questions have been raised: how do regulatory and financial incentives impact on recycling, and; in view of the low cost of virgin

⁵ A More Sustainable Supply Chain, by [Verónica H. Villena](#) and [Dennis A. Gioia](#). HBR, Cambridge USA, From the March–April 2020 Issue

⁶ Scheffer, M. (1992) Trading Places: Fashion, Retailers and the Changing Geography of Clothing Production. KNAG, Utrecht (PhD Thesis).

fibres there is a need to develop classification of waste streams by composition and possible follow-up usage enabling low cost separation and reliable further processing.

4.2.2.2 Services

These three questions are the most tangible raised in the last months and demand the development of methodologies, but then the annual actualisation and dissemination of data. An action point would be conducting a deeper market study or pilots on the feasibility of the following Wageningen series:

Life Cycle Analysis (LCA)

Increasingly, legislation, voluntary agreement and consumers (to start with institutional customers) demand for information on the footprint of products. This can be regarding GHG emissions, water, land use, labour conditions. In addition, this information is not only a matter of accountability but also a basis for informed choices by manufacturers, designers, buyers, consumers but also the start of evidence-based action plans. WUR plays already a role in supporting standards, e.g. through The Sustainability Coalition (TSC) (at WEcR) It is not for a university and public research institution to be party to a specific label system. It can however provide three things:

- (1) a place of debate and dialogue on standards and their significance, in Pillar 1,
- (2) to provide data and methods to underpin environmental impact assessment,
- (3) to assist in the execution of action plans for single companies, platforms, farmers cooperatives, in pillar 3.

LCA can also be performed under Pillar 3, mainly when part of contract/project research, or when it presents methodological questions. In order to develop the second idea, the setting up of methods and basic data is required. It is likely that such a system should be independent, but also adhere to (quasi)legal systems as e.g. the Covenant Eerlijke Kleding. Inspiration can be gained for land-based resources of the work done at WUR with spinoffs with Eagle Sensing and Satelligence. The proposals to conduct a feasibility study with WEcR and involve stakeholders in an expert meeting, and to come with a proposal with financial implications by November 31st 2020.

Cascading model

Several studies and stakeholders have demanded for a cascading model for textile recycling. Such an endeavour is also on the agenda of the Dutch ministry (a dashboard). A cascading model demanded is to be operational (and far more than a policy-oriented tool as currently done by Rijkswaterstaat, DCTV (Dutch Circular Textile Valley) or Gelderland). An operational cascading model is possibly a taxonomy (by input and output), a method to characterize waste streams with low costs, a feedstock analysis based on real time data, and a dashboard to monitor the transition for the next 30 years. As recycling is a global business the cascading model ideally becomes the global standard, as a further refined Eural system. Since the cascading model is of public interest it should be funded in a partnership project with governments, as a public procurement or with a subsidy. The system will need input and validation by stakeholders, that are in the sphere of influence of WUR. The action point is to advocate for such a system towards I&W and to create a round table of stakeholders.

Sustainable development goals

The industry has embraced the SDG as a basis for action plans, but the translation of SDG into practical operational guidelines operating in the dye house, the cutting room, the design lab is a difficulty experienced by stakeholders and companies having signed the GFP and GFA. Topics like implementing biodiversity in a fashion retail group is tough for a solitary executive with a general management degree. Since WUR is in conversation with several prospects on implementation of biodiversity recommendations, the start of a handbook could be on a material guideline for value chain and for landscape-based action plans. WUR has contacts that can be leveraged towards concrete assignments. A more generic material approach could enrich the rather "accounting" approach written by Cambridge University for GFP. A think tank on the material aspects of the SDG could be developed under the umbrella of the SER Covenant.

Hemp grading

This theme is much smaller in turnover potential than the former one but is currently an empty space. The idea into develop guidelines from site selection, soil preparation, plant selection, field management, fibre extraction and fibre grading for hemp. However, methods could be extended to flax (that are already well developed), cotton (in connection to previous points), but more importantly inputs for biopolymers and non-classic viscose (regenerated cellulose fibres). For hemp EURATEX has challenged WUR to develop an approach that has intrinsic merits and adhesion from major stakeholders (e.g. European Industrial Hemp Association, contacts already made). Public funding could be obtained, at when plants are considered as waste or as enriches as part of a plant rotation system. If extended to leather WLR would be in the lead. The animal welfare and biodiversity can be extended towards other animals used for material purposes (angora, cashmere, mink). This is a subject with high PR value but limited.

4.2.3 Pillar 3: Project and Contract Research

4.2.3.1 Introduction

It is of little relevance of precisising specific themes. The themes for 2020/22 are those themes identified by the different institutes in the July enquiry. Those themes are those for which WUR has already a track-record, expertise, transferable skills. The concept is that the program hub is pro-active hence actively looking for activities, clients and project funding and mobilising internal resources, but also assisting thematic program managers to find funding, partners and organising project activities. It is a combination of top-down activities (but with external legitimacy) and bottom-up activities (but validated externally). In both instances an adequate financial rule book is to be defined with clear lead and contracting rules. Essential is a covenant of contribution of project margin to development op pillars 1 and 2.

4.2.3.2 Short term priorities

The internal and external survey has led to the identification of a number of themes and prospects that should be materialized into contracts that support the ambitions of WUR and partners.

Domain 1 Bio-based fibres from field to fabric, from fabric to fibre

There is substantial knowledge at WUR on biobased fibres, both in the field of complex relations (plant genomic/breeding, field and primary extraction) as in further processing, either as natural fibre (e.g. hemp, flax) or as basis for viscose (as supplier of cellulose) or of sugars. Plant material can be a residue stream, as a rotational crop or as a full industrial crop. There is also much knowledge, experience and equipment on extraction of materials out of plant mass. In processing there are synergies with plastics and paper. This knowledge is often synergetic with mechanical and chemical recycling of textiles in order to enable processing of textile waste into regenerated fibres. Cascading may also involve converting other waste streams into textiles, or textile waste into other uses.

Domain 2 Water in textile production

Textiles are a big user of water, from field to laundry. In the past, WUR was in a seminal study in addressing the water use of cotton. However, all fibres require substantial amounts of water in crop production, separation, purification, functionalization, cleaning and even in disposal of fibres and textiles. While energy transition in production processes can be done with technologies that do not affect the primary process, water always affects the primary process of textile production. A program line on water may focus on green/blue water use in primary crop production, on water efficiency in all primary manufacturing processes, on alternative media for water (plasma treatments, supercritical CO₂, digital printing and finishing), on industrial and domestic maintenance of textiles (laundry) and on the impact of design choices for a number of water-based processes.

Domain 3 Biodiversity and textiles

Biodiversity has been chosen as key theme by global platforms. It is a theme where WUR has a lot of experience in research but also in engagement of stakeholders. In contrast, brands and their platforms struggle to define and engage effectively in this domain. The challenge is thus to prepare at short notice approaches that serve these platforms and their 100+ members. Content-wise three themes stand out: biodiversity and cotton production, biodiversity and leather production (leather being a residue stream of meat/milk production), and animal welfare (as a related area).

Domain 4 Policies for Circular textiles

The European Union and many member states are currently defining or precisising their policies for circularity and sustainability in textiles. These studies can be broad in scope or very specific (on Extended Producer Responsibility (EPR) or effectiveness of certification and auditing systems). It is not yet relevant to precise the scope of these studies, it is rather important to position WUR as a qualified partner for textile related studies for Dutch Ministries (BuZA, EZK, LNV, I&W) and with international organisations (e.g. EU, OECD, Unido) in upcoming tenders for textile related studies.

Domain 5 Elastane

Elastane has become an appreciated feature in clothing over the last 30 years. It is only 0,5% of global fibre consumption but is used in a much higher share of all clothing items. It is used in blends with almost all other types of fibre (cotton, linen, viscose, polyester, polyamide, wool). Elastane increases comfort, is forgiving for mismatches between body and sizing. Elastane is however also a major contaminant for the recycling of the bulk of the surrounding fibres, even if it is most often less than 5% of the fibre content. While stretch is a culturally appreciated characteristic, it presents two challenges: is it possible to develop biobased alternatives that do not pose problems during recycling, and how can elastane be removed from blended yarns or fabrics in recycling?