CASE 102

Clustering Fibers, Food and Biodiversity

Executive Summary:

Currently the major natural fiber used in the textile industry is cotton. Cotton also happens to have an incredibly large ecological footprint because of the way it is farmed. The search for alternative sources of fibres for the textile industry has led us to study nettle fibers and sea algae based textiles, both of which are underexploited resources that contribute greatly to biodiversity. Algae are not only an ideal source of fibers, these natural seaplants also sequesters carbon dioxide, can be used as a source of nutrition and a range of fine chemicals, leading to the creation of a new cluster. Another innovation in this cluster are coffee-laced textiles. The ability of coffee to absorb odors and give synthetic fibers a hydrophilic quality, is utilized to produce functional textiles. First you drink it, then you wear it. These novel options use locally available resources, were considered to have little value, end up creating value generating jobs and mobilizing capital.

Key words: Textile industry, Functional fibers, Sea Algae (seaweed), Malnutrition, Nettle, Coffee, Biodiversity, Competitiveness

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An Introduction to the future of fibers:

One of the interactions that triggered my interest in fibers was with Yvon Chouinard, of Patagonia, and his staff. When I built the first ecological factory in 1992, I ordered Capilene® underwear from Patagonia for all my workers, to keep them warm when I reduced the heating of the shop floor to save energy costs. This unusual order was met by disbelief from Patagonia's Paris representative who thought I was preparing for a major expedition to scale the Himalayas. I soon came to know Yvon Chouinard, the founder of Patagonia, who confided that I had placed the largest order for his new underwear to date. Over time Yvon shared concerns about the destructive

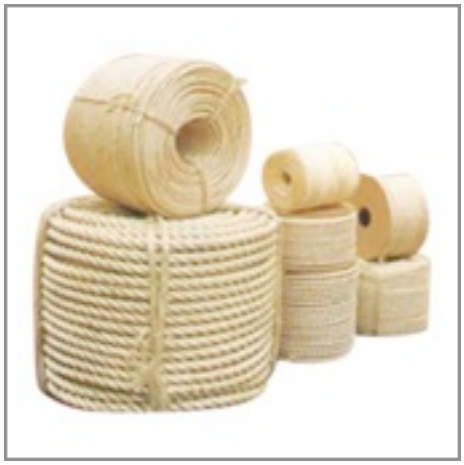
Yvon Chouinard Prof. Dr. Keto Mshigeni Sybilla Sorondo © Pauli/ZERI

environmental quality of his fibers. We had conference calls with his research staff in 1999, about alternative fibers that would at least be as good as conventional fibers, but not as damaging to the environment. I was still looking for ways to "do less bad."

The work of Prof. Dr. Keto Mshigeni, a Tanzanian-born, Hawai'i-trained marine scientist and of collaborator of ZERI at the United Nations University between 1995 and 2000 brought my attention to the plight of sisal. Sisal originated from Mexico, but was transplanted to East Africa where large estates were converted, over a century ago, to manufacture ship ropes, carpets, paper, cloth until synthetic substitutes caused the demise of a whole industry. Prof. Mshigeni, applying the ZERI logic of clustering industries, and searching to do more good with locally available resources, noted that as long as sisal was only used as fiber, it would loose against petroleum-based alternatives. Instead, if sisal were used for its natural sugars, it could provide alcohol.

Moreover, it could be used as animal feed or even to produce pharmaceuticals like hecogenin and inulin. In 1996 Prof. Mshigeni and I traveled to Tanga (Tanzania) to

Sisal plantation © Mongabay.com



Sisal ropes © Mongabay.com

witness the crisis of the sisal farms. Despite the scientific community's wealth of knowledge regarding opportunities for sisal, production dropped by over 50% in the following decade, resulting in the loss of thousands of jobs and livelihoods.

We are not alone in seeking alternatives to the way the current textile industry operates. Sybilla Sorondo, a prominent Argentinian-born fashion designer, made a name for herself with a portfolio for Louis Vuitton and her own brand Sybilla, which is popular in Japan. During a burn-out in her career, she reflected on the real impact of her products and realized that the materials rarely were natural and that few workers were paid sufficiently to make a living. On one of the Blue Economy training seminars held at her center in Mallorca, Sybilla and I discussed the possible ways forward. She soon created Fabrics for Freedom and started developing a series of integrated textile projects focused on the social and environmental performance.

The Catastrophe of cotton:

Witnessing the loss of sisal, and the associated jobs, brought me closer to the leading natural competitor for fibers: cotton. Katherine Tiddens, the founder of the ecological store, Terra Verde, in Soho, New York, had showed me the extraordinary variety of colours that cotton can naturally take on. She alerted me to the heavy ecological footprint of it: too much water and too many pesticides. It even seemed better to buy

synthetic than to buy cotton. A trip to China in 1997 put me face to face with the realities of cotton at the time. The United States lost competitiveness in cotton farming, but not because of the low cost of production in China. The rising cost of water, ground water pollution and the imposition to apply less toxic (and more expensive) chemicals to protect the cotton from caterpillars meant that the Americans were happy to transfer cotton production to China and India - today's number one and two worldwide cotton producers. As the years passed I noted the increasing unease of Prof. Dr. Li Wenhua, Member of the Chinese Academy of Sciences, with the huge water consumption and chemical use. China slowly woke up to the reality, as others had, and there was waning support amongst policy makers to continue the cotton boom.

The connection between Patagonia, Sisal and Cotton enticed me to create a special network for fibers of the future within ZERI. The future of cotton is determined by the extreme scarcity of water in China, and elsewhere. One T-shirt requires 2,700 liters of water. We researched and traveled the world, but the only major alternative we noted was hemp. But I felt that a lot of work had already been done on hemp - it already reached nearly 2 million tons of output in 2012. The substitution of cotton, a 30 million ton crop, with one crop will not provide a fundamental solution. There is a need to diversify supply so I opted to focus the creative energy of ZERI on different, less obvious opportunities than hemp.

The algae cluster

While a lot of research had been undertaken across China, the 2008 Summer Olympics provided a trigger to the design of an alternative strategy. The City of Qingdao was to host the water related Olympic Games. Unfortunately, every summer the portal zone is invaded by sea algae (we prefer not to use the term sea*weed*). Its prolific growth obliged the Municipalities to call upon the Chinese Army and Navy to clear the sea or cancel the Olympics, which was not an option. The total amount of algae collected right before the world games amounted to 2 million tons.

The sea algae were considered a weed, and were dumped in a landfill, generating methane gas. Scientists from the National Laboratory for New Materials at Qingdao University, worked with the Xiyingmen Group, one of the largest towel manufacturers of China and embarked on a research program to produce algae-based fibers. The total production potential of fibers from algae in China was estimated in 2009 at ten million tons. Field research, conducted in cooperation with the ZERI Foundation in 2012,

determined that Indonesia and India are the two other countries capable of replacing today's cotton supply chain with renewable alternative like extracts from marine algae. The macro-

Prof. Dr. Li Wenhua

Prof. Dr. Jorge Vieira Costa

Prof. Lucio Brusch

Dr. Michele Greque de Morais

than cotton farming- was now validated by research data.

It was Prof. Lucio Brusch, the founder of ZERI Brazil Foundation, who learned about algae while he was management professor at the Pontífica Universidad Católica do Rio Grande do Sul. He followed-up the discussion with Prof. Jorge Alberto Vieira Costa from the Federal University of Rio Grande. They noted that the South of Brazil hosts the world's largest biodiversity of micro-algae. Simultaneously, this region is faced with unacceptable levels of malnutrition. The professors embarked on a research program to farm algae to combat hunger, building a case supported by the strength of its biodiversity. They started with pilot programs in rice paddies in 1997 and soon extended the production of algae to the retention basins of coal fired power stations' cooling towers. This program became an integral part of the "Fome Zero" (zero hunger) initiative of the then Brazilian President Ignacio Lula Silva.

The team grew over the years into a remarkable center of algae knowledge that is today considered one of the top five in the world. While those focused on making fiber

discovered that their supply chain could produce nutrients, the algae producers from Brazil quickly realized that they could be producing fibers. Dr. Michele Greque de Morais, then a young doctoral candidate in Jorge's laboratory, first identified the pathway to extract esters from algae and obtained a patent for this breakthrough. CNpQ, the Brazilian research promotion council, supported the research and the findings with dozens of scientific articles published on the subject. The project in Brazil was unique in its consideration that fuel production from algae is not a priority. These research initiatives in the South primarily assessed plants and algae as sources of nutrition and fabrics. The new fibers are derived from locally available resources (micro-algae) that today do not provide any economic value. This follows one of the Blue Economy principles converting nothing (or something of no value) into something of high value.

The past years have seen a few breakthroughs. The German company - Smart Fiber AG (www.smartfiber.de), the producer of SeaCell- processes seaweed from the coast of Ireland to create its textile fibers. It can replace up to 25% of the fibers used to produce products like VitaSea fabric, marketed by Lululemon from Canada (www.lululemon.com/education/info/natural), and Underwear Options from the US (www.underwear-options.com/seacellfibers.html). While seaweed fabric is slow in penetrating the market, it is more a problem of supply. There is a need to finetune the technologies of production.

The Belgian company Sioen (www.sioen.be), embraced seaweed fibers and got the support of the Commission of the European Union to attempt to overcome the production challenges. The European Union now recognizes seaweed as an under-exploited resource for food, feed and biochemicals feedstock, including the ingredients to produce fabric. Bert Groenendaal, the R&D manager of Sioen, believes that, with the science covered, this emerging textile will generate a multi-billion industry that will boost

growth and jobs using an abundant, little appreciated resource. However, harvesting algae from the wild for rope and fiber cultivation will never emerge as a competitive force. Trials for methods of cultivation in Solund (Norway), Oban (Scotland) and Galway (Ireland) have demonstrated yields of 16 kg of farmed wet seaweed per square meter, with perspectives to increase to 20-25 kilograms. This is more than five times the yield of traditionally harvested seaweed in the open sea.

The Europeans interested in algae-based textiles also see the business as a cluster. The algae provide sea algae polysaccharides as additives for processed foods such as chocolate milk, yoghurt, and beer. A finer extraction could yield lipids, antioxidants, gelling agents, vitamins and essential minerals. It is the combination of food and textiles based on biodiversity that makes the innovations within the cluster so attractive. It is both profitable and has a reduced footprint on the environment: the algae absorb CO_2 which leads to the long term harnessing of this greenhouse gas. This changes the framework and the potential for quality of life, job generation and living within the carrying capacity of the ecosystem. This is quite different from cotton, where it all started.

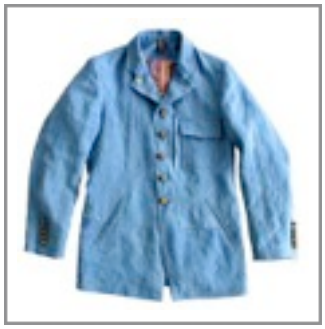
Alternative fiber: Nettle

When the ZERI España team traveled around the county of Lea Artibai in the Basque Region, to identify new business development opportunities from local resources, they found a wealth of nettle, which had once been used as a source of nutrition and clothing. The wisdom of the past has been replaced by cotton. ZARA, the Galicia-based textile giant is one of the biggest buyers of cotton in the world. The irony is that it is located on one of the richest marine algae and nettle regions in the world. After the local government was exposed to the opportunities of both, the political, civil and business leadership began redesigning their appreciation of the textile industry, which was long considered a part of history.

The EU funded a group of German, Austrian and Italian companies to advance the processing of nettles. This was under the leadership of Dr. Falko Feldmann, at the time the Scientific manager of the Institute for Plant Cultivation in Solkau, Germany (www.mykorrhiza.de). Nettles also drew attention in the UK with extensive research at Leicester's De Montford University, under the title Sustainable Technologies in Nettle Growing (STING). Camira Fabrics (www.camirafabrics.com/be-inspired/design-stories/

nettle-collection), a UK-based world leader in fabrics for commercial interiors, produces 8 million meters of fabric per year and includes nettle in its portfolio. Nettle also has

Nettles in the wild



Jacket by © Swicofil

Buthanese men in national dress (Goh)

become a core component of the quality textiles offered by the Swiss-based Swicofil (www.swicofil.com). They are one of the few textile companies that successfully maintained its competitive position in a high cost country through their remarkable innovations in fabrics. Swicofil sources its nettle yarn from Nepal. The Himalayas have an abundant supply of nettle, which grows prolifically up to 3,000 meters altitude in the wild. It displays both a wealth in history and positions itself as a fabric of the future. Even today, the Bhutanese men continue to wear their national dress, the Gho, traditionally made of nettle fibers.

While the European textile industry is slow in adopting any new natural fiber, Alex Dear, from Cambridge (UK), produced her own "nettle knickers" at the age of 23, as part of a lingerie series. Sue Clowes, the English textile and fashion designer is known for her nettle collection launched by Boy George, the British singer and songwriter. The internet millionaire Bob Crebas opted to create a new company- Brennels BV (www.netl.nl) to spearhead the production of nettle fashion products. He got the best seeds on the market and planted 80 HA of nettles in the Netherlands, with additional farming in the Czech Republic and Lithuania. However, this nettle venture closed down soon after its creation. The quick money made on internet ventures just did not match the patience required for the long haul in innovative fibers like nettles. The Blue Economy network that puts the ZERI philosophy in action is used to translate the vision, often sourced in fantasy, into reality balancing science with the appetite for risk.

Coffee Textiles

In 2006, Jason Chen, from Taiwan, started a new venture under the name Singtex. His market niche is functional textiles. He utilized what many already know from practice:

coffee absorbs odors. Jason and his team successfully managed to blend coffee into fibers to control odors. During their research, they also noted that coffee protects color pigments and fibers from ultraviolet rays, and can convert synthetic fiber to a hydrophilic fabric. The use of coffee (post-industrial and post-consumer) now has a new, surprising application: coffee textiles.

It was Bill Werlin, then the country manager of Patagonia in Japan, who alerted me first of this opportunity. A few weeks later, on a trip to Taiwan, I visited Singtex and the enthusiastic team that Jason and his wife had assembled. We had assumed that sustainable fabrics should be natural fabrics that form clusters of products and services from processing the biomass. However, sustainable fabrics could also be the partial substitution of petrochemical ingredients for synthetic fibers with organic input from coffee. Singtex is revolutionizing the textile industry. This innovation company, placed on the Taiwan Stock Exchange in 2014, now supplies over 100 well-known brands with

Jason Chen © Singtex

coffee-laced textiles. The product is not only changing the product design of Patagonia and Adidas, it is also stimulating entrepreneurship, as Javier Goyeneche, the founder of EcoAlf (www.ecoalf.com) has demonstrated. Perhaps the most charming marketing campaign for the use of coffee in shoe fabric was proposed by Timberland: "Drink it - Wear it". In view of the decades of work we have done with coffee farming, it seemed a surprising, yet logical, extension of our commitment to the livelihoods of the 640,000

coffee farmers in Colombia. So we set out to introduce Colombian coffee farmers to textiles made with coffee left-overs.

Our close relation with Singtex and the Colombian Federation of Coffee Farmers resulted in the creation of a new business proposal: textiles made with 100% Colombian coffee. Through exchanges a year of exchanges a new, integrated textile initiative was created in Colombia. It was Constanza Jaramillo, the executive director of Café Buendía, who emerged as the entrepreneur of this venture. Constanza produces in Chinchiná, in the heart of coffee farming region known as "El Eje Cafetero" instant coffee. The factory extracts with CO_2 the soluble part from the beans. The rest, 25 tons per day, is incinerated. A fact finding mission headed by Jason Chen identified the opportunity to separate coffee oil (up to 20%) from the solids, and use both fractions as additives to woven and non-woven textiles.

This shift from the incineration of waste to the creation of the raw materials for functional coffee-textiles came just when all strategists were concluding that the free trade agreements of Colombia would represent the end of the textile industry. The Blue Economy approach shows once more that this traditional economic analysis is wrong. Thanks to the technical assistance of Singtex, Lafayette (Bogota) produces yarn and and cloth, starting with the Colombian coffee grounds from the Cafe Buendia instant coffee production unit. SuperTex (Cali) converts this into fabric and Juan Valdez, the chain of 400 coffee shops owned by the farmers, sells the stylish T-shirts to the local market. The short term impact of this initiative for coffee and textiles on the global scale is tiny, but its potential is tremendous. It has the potential to shift the future for coffee farmers, using what is locally available, by offering products of a high performance at competitive prices.

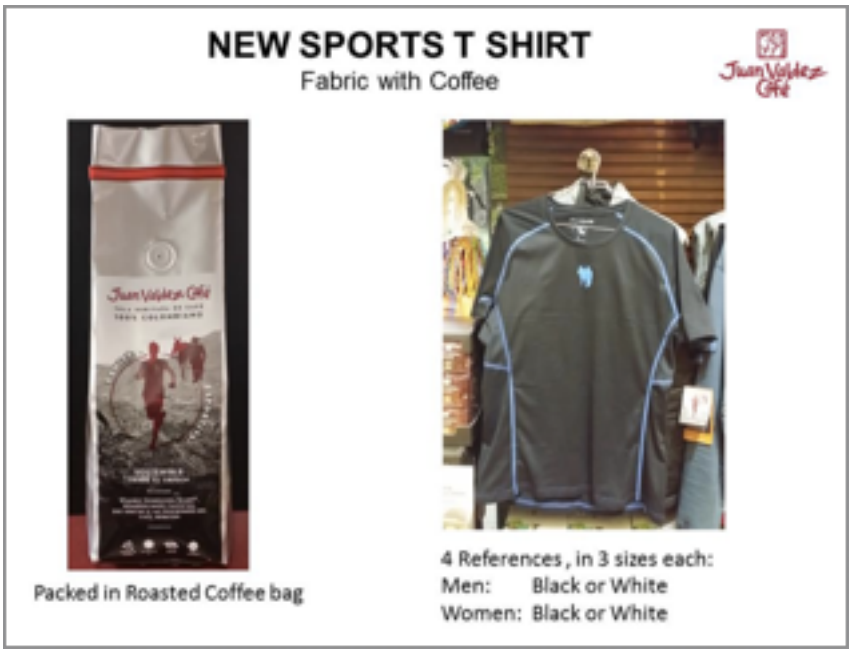
Functional textile yarn is expensive. However, when one can source the technical component from renewable sources, at prices that are higher than the value of the embedded energy, then it is possible to sell better quality at a lower price. Whereas no farmer can ever dream of getting more than a thousand dollars per ton of coffee, its waste can now be converted into an input for fabric that not only offers a unique selling proposition, it even pays better. This is what the Blue Economy is all about.

Conclusion

We have been in search for the "next" textile industry for nearly two decades and have explored a few options. We are certain that the global network of researchers that we have enjoyed working with and reaching out to is only a fraction of the emerging shift from cotton to a wide array of "blue fibers". Since this cluster does not cover the work of Novamont in Italy, with the production of polymers from agricultural waste, nor does it analyze the pioneering research initiatives of Prof. Dr. Fritz Vollrath with natural polymers produced by insects, since both are part of other cases, it already demonstrates that a completely new field of industries is emerging, where the competitive strength is not the lipid or the oils contained in the plants or algae, but rather the combination of nutritious food and functional fabrics.

While our network continues to monitor multiple entrepreneurial initiatives and interact with all these players through our local researchers and shakers, we are keeping the pulse on the arrival of urgently needed breakthroughs, while addressing the dynamics of job generation in regions where the textile industry was written off.

Therefore, this cluster is part of a re-industrialization drive that characterizes the Blue Economy initiatives. We are tallying to date US$120 million investments in research and development, capital investments and marketing programs with the bulk of the money spent in China and Taiwan, followed closely by the research programs in Brazil. While there is at least a 20-fold investment in algae to fuel, we make abstraction of that number since we have no relation with the players. More important is that we do not believe that this is the strategic shift we need. Burning biomass or an extract should always remain the last option. When it comes to the creation of jobs, the present number indicates that the narrowly defined activities in this



cluster employ 1,400 persons directly, and that indirect job creation adds another 1,100, especially in the downstream sales and marketing activities.

We know that the Earth is not capable of producing more cotton. In addition, we need to reduce our consumption of cotton as much as we have to cut our intake of meat. And just like we need to produce protein more sustainably, we need to clothe the world in a more intelligent manner. In the end, we have to learn to do more with what the Earth is delivering instead of exhausting already scarce resources like land and water. This will permit us to create a new reality, where we can meet the basic needs of all.

Translation into Gunter's Fables

The business of nettle textiles is translated into the fable #51 entitled "Nettles Sting". It is dedicated to Sybilla Sorondo who inspired the creation of this cluster, in 2004, with her self-critique of the fashion industry and her commitment, in 2009, to create Fabrics for Freedom. The innovative use of algae is translated into fable #39 entitled "Dressed Up in Algae". It is dedicated to Suzanne Lee, who created BioCouture with the purpose of promoting bio-design of fashion. Both fables will be published first in Chinese and English in China and will be available as an e-book on <www.guntersfables.org>.

Documentation

http://www.feldmann-lifescience.de/transfers/Urtica.htm

http://sff.arts.ac.uk/Fibre%20Processing/bastfibresproces.html