Case 77

Fibers from Algae

By Gunter Pauli

This article introduces algae transformed into fibers as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world's output of natural fibers produced from plants and animals reached the $50 billion mark in 2010 for a total production of 35 million tons, of which 23 million tons are reserved for textiles and clothing. The balance of 12 million tons is used in a series of industrial and consumer product applications like the reinforcement of thermoplastic panels in European cars, composite boards with coconut fibers that are more resistant than teak in the Indian construction industry, roofing reinforced with sisal in Brazil, hemp blended in cement used in China for the 2008 Olympics. The global market for natural fiber composites in the automobile, construction, sports and leisure industry was valued at $2.1 billion in 2010, and it is expected to more than double by 2015. BMW vehicles contain up to 24 kilograms of flax and sisal which are transformed into composites for indoor panels or instrument boards. The Mercedes Benz A class car uses natural composites in the underbody panels not only because of their natural origin, rather because of performance in terms of weight and durability.

The largest natural fiber produced in the world with an output of 25 million tons in 2010 is cotton. The three biggest cotton producers are China (32%), India (22%) and USA (12%). However, cotton is on the decline, especially in the US where this natural fiber's farming area dropped 30 percent in one year to just over 3 million HA, the lowest since 1983. Whereas the decline has been traditionally due to the replacement of natural by synthetic fibers, the global trend is reinforced by the Chinese wish to farm food on land that is now reserved for cotton. China wants to broadly substitute the water intensive cotton farms with food crops. They have opted to substitute cotton with industrial hemp. The cultivation of hemp will expand from an modest 20,000 HA at present to perhaps as much as 1.3 million HA in a few years. Hemp grows prolific on hilly and less fertile soil without any need for irrigation while stabilizing erosion, a key ecosystem service. The second most important natural fiber produced in the world is jute, good for 2.9 million tons and mainly produced in India, commanding higher prices (up to $400/T) than cotton since it is predominantly used as a substitute for plastic packaging and therefore linked to the international price for petroleum.

The Innovation

Natural fibers are popular and demand is overall on the rise. Variations in quality, the low fire resistance (except wool), and the low impact strength are limiting its broader industrialized use. On the other hand, high stiffness and the ability to break without leaving rough and dangerous edges are considered advantages. However, one of the greatest challenges remains that most plant fibers compete for land and water with food production. There are attempts to convert -for example- water hyacinth into strong fibers useful to manufacture furniture and accessories. This invasive species clogs rivers and dams in Africa and Asia, feeding off nutrients that accumulate in water bodies due to soil erosion and excessive use of fertilizers. Except for some minor breakthroughs for this aquatic plant in Thailand and Bangladesh, there is a need to find naturally occurring and widely available renewable fiber resources that can be converted into quality products without competing with food.

Ji Yujun was the chair of the 7th, 8th, 9th and 10th National People's Congress of China but in his heart he is an entrepreneur. His concern as a party official has always been how to grow the economy while securing social welfare. He started his career in 1980 as the director of a towel factory which was incapable of meeting quality standards. It were the times of the planned economy when cotton supply was still at random and often beyond control of a plant manager. Under the leadership of Ji Yujun quality recovered and subsequently production increased thanks to the import of advanced equipment from Japan and Germany. Mr. Yujun went on to merge the towel company with state owned and township enterprises under the Xi Ying Men brand. This brand emerged in 2005 as the top brand in Chinese textile industry. While consolidating production, he decided to invest in research to differentiate supply.

Ji Yujun and his team were inspired by the fact that each year in June and July green algae appear along the Qingdao Coastline, consuming large amounts of oxygen, threatening marine life and fisheries. In 2007, an algae outbreak in Taihu, China's third largest freshwater lake stopped tap water supply to more than one million people in Wuxi, Jiangsu Province for about ten days. Volunteers and the army cleared almost a million tons of algae from the sea before the Olympic sailing competition of the 2008 Games could start in Qingdao. Since algae blooms frequently cause havoc in China's waterways and threaten marine ecology and fisheries, it was agreed to undertake a joint research initiative with the National Laboratory for New Materials of the University of Qingdao, on the potential of algae as a source for fibers.

The First Cash Flow

The original fibers were fragile and only served for medical textiles such as bandages and surgical dressing. Then the team succeeded in finetuning a new extracting process for raw materials for fibers from kelp. Motivated by the fact that these fibers were stronger and more durable than cotton, the research team tested the extraction of high strength alginate fibers from a wide variety of brown, green and red algae. The research team discovered that the new fibers are resistant to fire and electromagnetic waves. Thus, the algae-based fibers provide a unique raw material to manufacture special clothing, such as fireproof gear, medical uniforms and protective clothing with military applications.

The newly developed alginate extraction process permits to obtain 200 to 250 kilograms of raw material for each ton of dry algae. The cost of production of alginate fiber varies from $8,000 to 10,000 per ton. Since China is the world's largest algae aquaculture country with approximately half of the world's low-end output, it has an abundance of raw materials to produce alginate-based fibers. This means that the low value algae can be sold at high value prices. Better even, each year the clean-up of the algae blooms is converted into a source of employment and quality products, with a proven value on the market. The feedback from initial trials with customers motivated Mr. Yujun to build a 1,000 tons fiber plant in Qingdao which has come on stream in 2011.

The Opportunity

Early sales of algae-based textile products have gained a positive customer acceptance since there is a broad awareness of the capacity of algae extracts to regenerate and maintain a healthy skin. The potential output of renewable alginate fibers from China based on available resources in the country could reach 1.9 million tons annually. This turns algae fibers from nowhere into the third most important natural fiber on the market. This implies that China (and the world) could further reduce its dependency on pesticide dependent and water intensive cotton without the need of land space for farming. The textile applications for algae-fibers already evolved from bandages and specialty wear to fashionable products.

New fashion labels emerge, like "Twosquaremeter" in Germany, a start-up company offering clothing that includes algae with the independently verified claims that the skin soothes and regenerates by wearing algae-based textiles. A skirt or dress may cost € 100 to € 250, and while that is a multiple of the sales prices that Zara or H&M charge, it is only a fraction of the famous brands. Thus algae-based textiles are carving out a niche for clothing that is healthy for the person who wears it and for nature from where it is sustainably harvested. If the source includes algae blooms, then one looks at an exemplary application of the concept of the Blue Economy. Whatever the cost to remove algae, these fresh or sea water resources then provide a revenue, respond to a real demand on the market and generate jobs, a marked improvement over dumping the prolific biomass in landfills where it rots and generates methane ga

The potential of the seaweed fibers has attracted competitors. The Qingdao Xi Ying Men Group may have the largest production unit in the world, but competitors have arrived like New Fibers Textile Corporation from Taiwan that manufactures a fiber that is a combination of cellulose and seaweed, both touted as renewable resources. The German chemical group Zimmer AG had pioneered similar fibers, but sold the operations to Smart Fiber AG which now has a production capacity of 500 tons per year in Rudolstadt based on North Sea harvested algae which it decided to move to the Lenzing factory in Austria, a leader in cellulose fibers. The team at Smart Fiber is producing antibacterial, odor-reducing, skin-caring, temperature regulating, electrical conductive as well as chemically and thermally resistant fibers. Now we enter the market of therapeutic and functional textiles, and this opens a new world for entrepreneurs worldwide.

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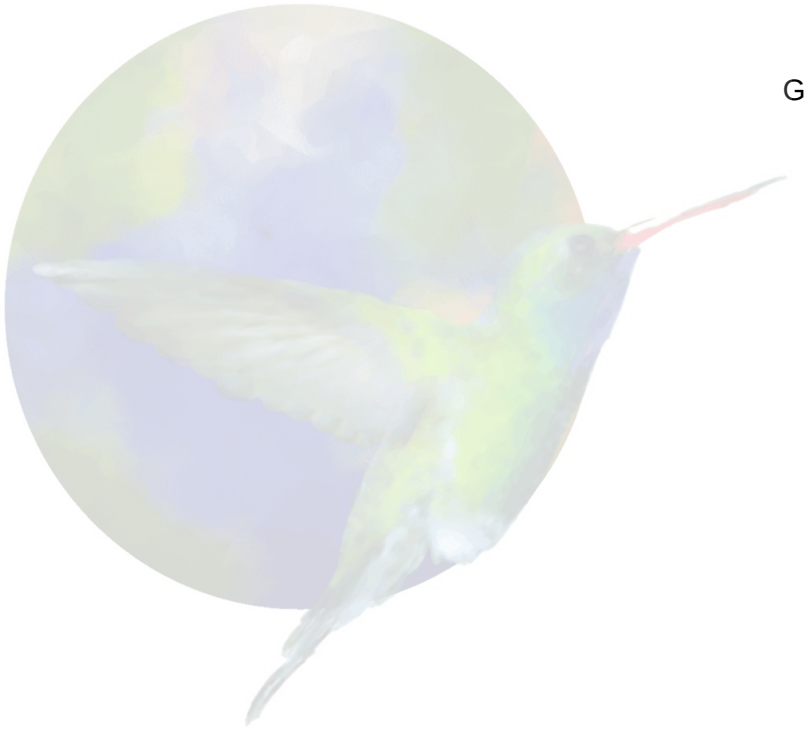

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… Further information on the 100 innovations at www.theblueeconomy.org

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