

Hemp and its Ability to Create a More Sustainable Future

At the center of the world's economy is shipping. According to the International Chamber of Shipping (2022) "11 billion tons of goods are transported by ship each year - or 1.5 tons per person based on the current global population". Among the 11 billion tons of goods, is a variety of packaging materials used to transport them safely and securely - many of which rely heavily on the use of corrugated board. This corrugated board is derived from softwood tree fibers to make pulp in order to create strong enough fibers to protect the product within them (Daggar, 2022). While this process has proven efficient, there proves to be a more sustainable method to paper products through the cultivation of hemp. While hemp was illegal until 2018 under the Controlled Substance Act (Marian J Lee, 2019), it has since been removed through the 2018 Farm Bill and given a path for both research and commercial purposes. Due to hemp's untapped economic benefits and improved water conservation and environmental benefits, hemp is the most beneficial replacement for timber in order to create a more sustainable and cost effective shipping industry.

The origins of paper date to 2nd century China, as an alternative writing material to silk (Hiziroglu, 2016), and traveled through the Eastern world and Europe over the next thousand years. Paper was originally made from papyrus and evolved to hemp, flax and occasionally cotton rags as these were the only raw materials available at the time. The paper making process remained generally unchanged through the 18th century (Britt, 2020) until a shortage of materials required new innovation and development to include wood and vegetable pulps which aided in making large-scale production possible. Two pathways were created for paper production: mechanical or chemical. Mechanical production required the separation of fibers from the wood structure while chemical production "exposed the wood to a chemical solution

that dissolved and removed lignin, leaving cellulose fiber behind" (Britt, 2020). Today, wood is the predominant source of papermaking fiber. Because of this growing demand, the concern for deforestation has increased greatly. According to Georgette Kilgore (2023), between 4-8 billion trees are used annually for paper. Deforestation contributes to the loss of animals, increases air pollution, and depletes the biodiversity of a region. In 2021 alone, "the global production of packaging paper and paperboard reached a high of 264 million metric tons" (Statista Research Department, 2022). As the demand for paper increases and the risk of climate change persists, it is important the paper industry evolves again to include a more sustainable method of production with hemp.

Hemp offers a wide variety of benefits to water conservation and soil quality. Per Malachowska et. al (2015), due to containing three times the amount of cellulose, one hectare of hemp can produce quadruple the amount of paper when compared to one hectare of forest. Bridget Gay, a hemp farmer from High Country Lab, explains hemp plants require around 6 gallons of water per plant per week compared to the necessary 10 gallons of water for every inch of a tree's diameter (Nichols, 2018). In regards to hemp farming, hemp's short growing season makes it beneficial to crop rotation allowing it to be harvested once other crops have been cultivated. Hemp breaks the soil with its long penetrative roots leaving it in favorable condition for the following year (New Billion-Dollar Crop, 1938). It is reported hemp cultivation leads to a 10%-20% increase in wheat yields, per the United Nations. In addition, hemp does not need pesticides and herbicides (Van Roekel, 1994). These factors are important to consider when faced with the barriers of population growth and the increased demand for food.

In addition, hemp paper requires fewer chemicals to make than traditional paper. In order to get a certain whiteness, modern wood pulp mills require a multitude of chemicals including

but not limited to, chlorine, sodium hypochlorite, chlorine dioxide, hydrogen peroxide, and ozone. The chemical chlorine dioxide makes it possible to "achieve high degrees of purification and brightness without the degradation of cellulose" (Britt, 2020). The hemp dying process is much simpler and can be accomplished with only hydrogen peroxide (Van Roekel, 1994). This process limits the amount of chlorine and dioxins injected into waterways keeping groundwater from excessive contamination.

Furthermore, hemp paper lasts longer than traditional wood paper, limiting decomposition and refraining from yellowing (Malachowska et al, 2015). When thinking of products from a holistic approach, it is important to consider lifespan when using raw materials for production. Noting hemp can be harvested in 4 months compared to trees requiring 20-80 years of growth depending on the type, demonstrates a quicker return on investment.

Thanks to the Farm Bill, hemp was legalized again in 2018. The lengthy timespan between its legalization limited the creation of technology necessary for its mass production (Van Roekel, 1994). While this is currently a con, it is also an opportunity as it gives researchers and entrepreneurs the permission to develop and create technological advancement with hemp. As awareness of hemp's benefits grow, "the global market could hit \$18.6 billion by 2027 - almost four times the amount in 2020" per the United Nations Conference on Trade and Development.

This work is already occurring at Washington State University and Oregon State University. Professor Jinwen Zhang of the School of Engineering at WSU developed an epoxy based resin from hemp seed oil to replace traditional epoxies (Li et. al, 2018). Also Kaichang Li of OSU's School of Engineering helped develop pressure sensitive adhesives originally from soybean oil then with hemp seed oil. (Qiu et. al, 2011). While these are limited examples, hemp has the potential to provide sustainable alternatives to timber, petroleum, and soy products in the

shipping industry. Society can continue to progress forward with this by investing in hemp farming and hemp processing facilities creating new jobs and new possibilities across the supply chain (Safe Harbor Financial, 2023).

The goal is not to become solely reliant on hemp but provide thoughtful alternatives to the current processes that exist specifically in the growing shipping industry. Remembering history and the impact hemp offered prior to its legalization can benefit the Earth and its changing climate. Not only does hemp offer environmental benefits but it also creates financial prosperity given the whole plant is of benefit rather than an individual part. Because hemp requires less water, yields a higher crop, and grows in a significantly less amount of time than trees, it is time hemp is legalized worldwide and used as an alternative to timber in the shipping industry.

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