Evaluating Alternative & Non-Wood Fiber Use in Packaging

Assessing Myths and Tradeoffs Around Packaging from Alternative Fiber

RESOURCE

PACKAGING DESIGN

GreenBlue is an environmental nonprofit dedicated to the sustainable use of materials in society. We bring together a diversity of stakeholders to encourage innovation and best practices to promote the creation of a more sustainable materials economy.

The Sustainable Packaging Coalition (SPC) is a membership-based collaborative that believes in the power of industry to make packaging more sustainable. We are the leading voice on sustainable packaging and we are passionate about the creation of packaging that is good for people + the environment. Our mission is to bring packaging sustainability stakeholders together to catalyze actionable improvements to packaging systems and lend an authoritative voice on issues related to packaging sustainability. The Sustainable Packaging Coalition is a trademark project of GreenBlue Org.

SUSTAINABLE PACKAGING COALITION®

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Considerations for Non-Wood Fiber Use in Packaging

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EXECUTIVE SUMMARY

The packaging industry is entering a new era of "Paperization", a trend driven by dual consideration of environmental impact and consumer interest in alternative, non-plastic packaging materials and formats. Innovation in barrier coatings and performance characteristics is allowing fiber-based packaging formats to enter spaces that have long been considered plastic-only. This guide focuses on a subset of the fiber-based packaging landscape: alternative fibers derived from non-wood sources. The guide will introduce non-wood fiber sources and investigate important considerations for utilizing across the packaging life cycle, from sourcing through end-of-life.

While a small fraction of the current global pulp supply is derived from non-wood sources, there is building interest in the packaging industry in how these fibers fit into the fiber-based packaging landscape and the larger packaging landscape overall. At the forefront of this interest is the perceived opportunity for alternative non-wood fibers to reduce impact, both compared to negatively perceived materials like plastic as well materials that are viewed as solutions to issues in the space, including traditional wood fibers. This raises a number of important questions this guide will aim to address.

Can alternative fiber sources play a role in reducing pressure on forested lands?

Can alternative fibers provide the packaging industry with a reliable alternative to wood fibers?

Does using alternative fibers enable brands to create packaging with a lower environmental footprint?

COMMON TERMS

- ***Biomass:*** *renewable organic material that comes from plants or animals used as a product feedstock or for fuel, typically to generate steam or electricity. Often expressed in terms of mass (dry organic matter) or energy.*
- ***Cover Crop:*** *crops either purposely planted or left on a field to slow erosion, store nutrients, retain water, and improve soil fertility.*
- ***Fiber-Based:*** *packaging created using fibrous materials that were pulped.*
- ***Lignin:*** *the natural glue that holds plant fibers together. Less "glue" means non-woods require fewer chemicals and less time, heat and pressure to separate fibers.*
- ***Marginal Lands:*** *lands not suitable for food production or traditional food crops.*
- ***Non-Wood Fibers*** *(i.e. alternative fibers, non-tree fibers, agricultural fibers): fibrous, plant-based materials, other than tree-wood, that can be used in paper and packaging manufacturing.*
- ***Recycled Fibers:*** *fibers from pre- and post- consumer sources that were diverted from the waste stream, and then collected, sorted, reprocessed, and converted into a feedstock to be used in another product.*
- ***Residues*** *(i.e. by-products):*
  - ***Crop Residues*** *(i.e. agricultural residues, agro-residues, agriculture by-products): biomass produced as a result of harvesting and processing of agricultural crops. Some residues can be left on the field to provide erosion control and improve soil fertility. Other uses include food for livestock, bioenergy, and inputs for manufacturing other non-paper and packaging goods.*
  - ***Forestry Residues:*** *wood (usually non-stem; e.g. branches, leaves, bark, unmerchantable wood, etc.) that is left over after thinning, harvesting, or sawmill activities.*
- ***Traceability:*** *the ability to identify, record and track the origin, history, and use of wood and fiber-based products through the supply chain. Effective traceability improves supply chain visibility and resilience, allowing companies to identify and target potential risks, improve system efficiency, and communicate more transparently with customers.*
- ***Tree Wood:*** *fibrous, mostly dead transport and structural tissue (i.e. wood, secondary xylem) from trees (e.g. not woody vines or shrubs)*
- ***Virgin Wood or Fiber*** *(i.e. new fiber, fresh fiber): non-recycled wood fiber that is primarily extracted from hardwood and softwood trees*

Part 1: What are alternative, non-wood fibers?

Fibers derived from non-traditional sources, as opposed to those derived from hardwood and softwood trees, that can be used for paper and packaging. Alternative fibers can be purpose-grown plants, such as bamboo, or be derived from byproducts or residues of crops, such as wheat straw or bagasse. Some possess desirable traits like fast growth or the ability to be grown on marginal lands, which at times must be weighed against possible negative consequences such as high invasive potential. Many non-wood fiber sources have existing markets outside of the packaging space.

Part 2: Alternative fibers have impacts through the package life cycle.

Alternative fibers differ from traditional wood fibers through the packaging life cycle and consideration to how these fibers will impact the packaging value chain is important. Alternative fiber supply chains often do not have the responsible sourcing certifications similar to wood fiber supply chains, meaning companies will need to perform proper due diligence to mitigate risk. Alternative fibers can provide desirable traits for packaging applications, but processing and manufacturing conditions may differ from wood fibers. Companies will also need to ensure that alternative fibers do not impact the ability of the package to be recovered via recycling or other end of life management options.

Part 3: Understanding the assumptions and tradeoffs associated with alternative fiber use supports sound decision making.

Perceived benefits such as the ability of alternative fiber sources to alleviate pressure on forests or reduce the environmental impact of fiber-based packaging are behind the increasing interest in their use. Fully understanding existing assumptions and the tradeoffs between the use of alternative and traditional wood fibers will ensure package designers do not greenwash or cause unintended impacts.

Part 4: Alternative fiber sources have their place. Consider where alternative fibers fit best and make appropriate goals for their use.

The variety of non-wood fibers on the market today offers the ability to find alternatives to wood fibers that can fit your packaging needs. Putting alternative fiber use in the proper context and setting appropriate goals will support their incorporation into your packaging portfolio.

1. What are alternative fibers?

Although the use of wood fiber for packaging is widely established and benefits from economies of scale, some companies are looking closer at alternative fibers.. Some are motivated to reduce impacts on forests, driven by a sense that this can be done by reducing harvests or utilization of wood for paper and packaging. Others are motivated by cost and waste utilization, assuming non-wood fibers represent an opportunity to reduce fiber sourcing costs, in part by utilizing a material that's currently viewed as a waste product. In part 2 of this guide, these and other assumptions are explored and unpacked in more detail.

The goal of this guide is to provide SPC members with a sense of the considerations for alternative fiber use in paper and packaging. This guide summarizes the sustainability tradeoffs of such feedstocks, and aims to establish goals for the sustainable use of alternative fibers.

ALTERNATIVE FIBER OVERVIEW

Alternative, non-wood fibers refer to those derived from non-hardwood or softwood tree sources. As fiber-based packaging formats become increasingly prevalent, designers and brands have expressed concern with the sustainable use of wood for packaging and associated environmental impacts. Alternative fibers are sometimes considered as an additional feedstock to support growth in the fiber-based packaging space and as an option that may help address concerns of using wood-based fibers.

The World Wildlife Foundation estimates paper and paperboard packaging accounts for approximately 13-15% of total wood consumption, with the industry using approximately 33-40% of all industrial wood traded globally. Additionally, the Union of Concerned Scientists notes that demand is expected to grow more quickly for pulp and paper than other wood uses, doubling to tripling by 2060.

In regions with robust forest resources and mature forest product supply chains, there are few incentives to invest in non-wood R&D or to convert wood-fiber mills to incorporate other fiber types. Though it is still a minor feedstock for packaging applications, the use of non-wood fibers may become more common as companies continue to explore alternative feedstocks for sustainability and cost reasons.

Alternative fiber sources are sometimes treated as a monolith, but they are in fact variable in their sustainability impacts and applications. Many non-wood plants can be used in a variety of paper grades, though ultimately their physical and chemical properties and desired paper attributes will dictate how they are used. This guide uses the terms alternative and non-wood to describe the broad range of fibrous, plant-based materials that can be used to make paper and packaging.

Paper and paperboard packaging accounts for approximately

13-15%

of total wood consumption

Source: World Wildlife Foundation

TYPES OF ALTERNATIVE FIBERS

Non-wood fibers are derived from two sources - plants grown as a crop, or from crop residues. Crop residues are generated as a byproduct of harvesting or produced during crop processing. Bamboo is grown as an agricultural crop, whereas wheat straw and bagasse are examples of crop residues. Of the alternative fibers available on the market today, bamboo is the most prevalent.

Region	2015 Capacity	2020 Capacity	Historic CAGR	Announced Non-Wood Capacity 2020 to 2025	Projected CAGR
AP	*7,008,500*	*6,716,400*	*-0.8%*	*2,960,000*	*7.6%*
EMEA	*568,300*	*546,600*	*-0.8%*	*35,000*	*1.2%*
NA	*8,900*	*44,400*	*38.0%*	*350,000*	*54.8%*
LA	*570,000*	*452,300*	*-4.5%*	*0*	*0.0%*
GLOBAL	*8,155,800*	*7,759,700*	*-1.0%*	*3,345,000*	*7.4%*

Table: Global Alternative Fiber Capacities (metric tons) (source: Fisher International and RISI via TAPPI)

Bamboo

Bamboo is a tall, treelike grass that grows incredibly fast (in some cases, 23 inches or more per day). Known for its versatility and strength, bamboo can be used for erosion control, as a food source, as a building material, for biofuel, and in goods manufacturing. Bamboo can grow in a variety of environmental conditions, including on marginal or degraded lands. All these traits, matched with bamboo's ability to store carbon at comparable or higher rates than many tree species, has earned the plant global attention. Concerns have been raised over bamboo as an invasive species and potential for other negative environmental impacts (e.g., conversion of mixed forest lands to monoculture bamboo plantations, loss of biodiversity, heavy reliance on synthetic soil additives, etc.) as the plant has grown in popularity.

Bagasse

Bagasse is an agricultural residue produced after sugarcane stocks, grown in subtropical regions such as Brazil or the Southeast United States, have been crushed and juiced for sugar. For every 10 tons of sugarcane processed, about three tonnes of bagasse is produced. Bagasse is currently widely used for livestock feed and bioenergy (including as a fuel source for sugar mills).

Wheat Straw

Wheat straw stalks are an agricultural residue left over after wheat grains and chaff are harvested. Wheat straw can be used as a cover crop, tilled into the soil, and used as an energy crop. Wheat is commercially farmed around the world. Before North American and European wood markets matured, wheat straw was a common feedstock for pulp and paper. However, in response to more costly labor and storage, stricter environmental regulations, and new technological advancements that improved wood-fiber pulping outcomes (e.g. kraft chemical recovery), mills pivoted towards virgin wood and recycled sources. By the end of the 1960s, no US mills used wheat straw as a fiber source.

Switchgrass

Switchgrass is a perennial grass native to North America and core component of Great Plains tallgrass prairies. Switchgrass is known for its rapid growth, ability to produce abundant biomass, and adaptability in a variety of environmental conditions. There are two main morphological ecotypes of switchgrass recognized, upland and lowland, which differ in the soil and height, subsequently impacting the amount of biomass produced. Switchgrass is primarily viewed as an energy crop, similar to giant miscanthus, and is seen as advantageous over other energy crops like corn due to its hardiness and adaptability, including the ability to be grown on marginal lands. It provides valuable soil protection as a cover crop and wildlife habitat.

Industrial Hemp

Industrial hemp is a non-intoxicating or non-psychoactive, fastgrowing, annual plant that is primarily grown for its fiber and seed. Hemp can be used to make bioplastics, textiles, and paper, as well as medicinally, in personal care products, and as a food. As of the 2018 Farm Bill, the United States defines hemp as varieties of Cannabis that contain 0.3% or less THC (Tetrahydrocannabinol). This law helped to legally separate industrial hemp from other varieties of cannabis (those that contain much larger amounts of the psychoactive compound THC). As the cultivation of hemp was illegal for some time in the US, navigating changing policies and laws may make supply chain logistics more complex. Industrial hemp is currently grown around the globe, with Europe as the largest producer.

Kenaf

Kenaf is a fast growing, herbaceous annual with two unique fiber types - long fibers located in bast or bark and short fibers located in the core of the plant. The plan is typically grown Southeast Asia. While primarily grown as a jute substitute (used to make items like rope, twine, or woven sacks), kenaf can be used as a fiber source for paper and packaging or as livestock feed.

Giant Miscanthus

Giant Miscanthus is a fast-growing, sterile perennial grass native Asia. Its efficient nitrogen use, and low nutrient and water requirements make Giant Miscanthus a productive energy crop that can support carbon storage on marginal lands.

Arundo

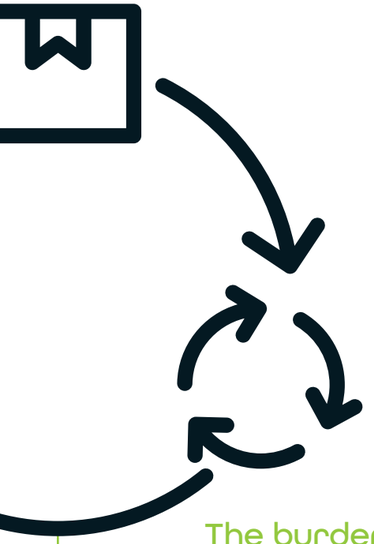
Arundo is an extremely fast-growing, perennial grass native to Eastern Asia. Examples include elephant grass, carrizo, Spanish cane, Colorado river reed. It can grow on marginal lands, withstand a range of environmental and soil conditions (including salinity), and is incredibly productive (it can grow up to 2 inches per day). Arundo is now considered by many to have high invasive potential in the United States. Native ecosystems, and especially riparian areas, are susceptible to invasion by the plant. When properly managed, some sources suggest that Arundo would not pose a significant risk to terrestrial systems.

ALTERNATIVE FIBER SOURCE CHARACTERISTICS

	Bamboo	Bagasse	Wheat Straw	Switchgrass	Industrial Hemp	Kenaf	Giant Miscanthus	Arundo
Agricultural Crop	✓			✓	✓	✓	✓	✓
Residue		✓	✓					
High Invasive Potential	✓							✓
Fast Growing	✓			✓	✓	✓	✓	✓
Energy Crop				✓			✓	✓
Grows on Marginal Lands	✓			✓			✓	✓
Annual			✓		✓	✓		
Perennial	✓			✓	✓	✓	✓	✓

ALTERNATIVE FIBERS IN A PRODUCT'S LIFE CYCLE

To better understand the environmental implications of using alternative fibers, it is first helpful to look at how they are sourced, used in the pulping and papermaking processes, and disposed of at end-of-life. **The life cycles of traditional wood and alternative fibers have numerous differences as discussed below.**



Sourcing

A key difference between forest production systems and the agricultural systems used to produce alternative fibers is the frequency of disturbance. In typical US forests, the cycle starts with harvest, which may include some initial planting and effort to reestablish the next cycle of trees. Aftwards, natural regeneration and growth of the forest occurs, possibly going decades without intervention. Landowners, foresters, or ecologists may monitor for changes to forest health, but tree growth will continue for years until the cycle is repeated. Over the course of a 50-year timeframe, there may be a handful of disturbances. In the meantime, the forest provides a myriad of benefits, such carbon uptake, water filtration, wildlife habitat, and recreation.

In an agricultural system, there may be hundreds of soil-disrupting events over the same 50-year time horizon, driven by differences in plant growth and harvest practices. Soil may be cultivated multiple times and artificial chemicals may be utilized at a higher rate compared to a forest production system used to produce equivalent biomass, leading to possible soil degradation and loss of habitat.

The burden is ultimately on the companies utilizing the alternative fiber feedstocks to perform adequate due diligence into their supply chains, and to mitigate environmental, social, and reputational risk.

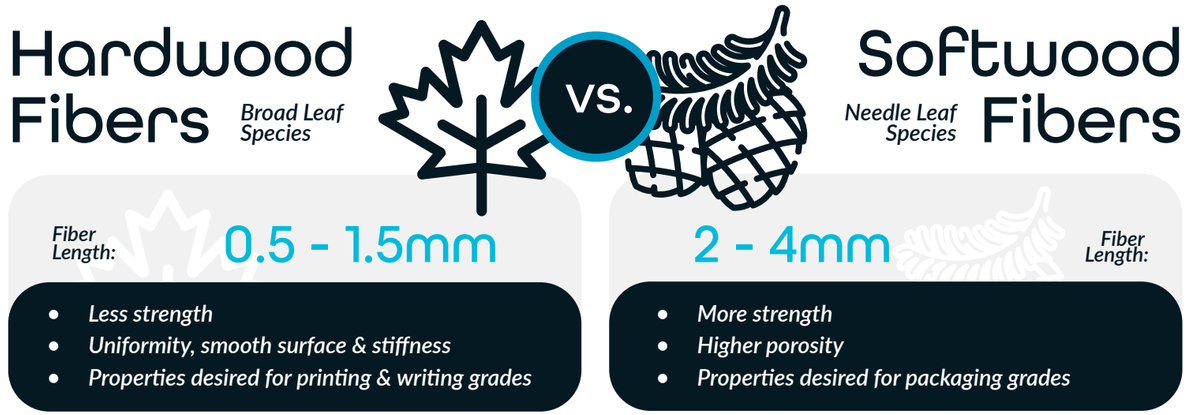
Forest management practices and chain of custody can be certified through bodies like the **Forest Steward Council (FSC)** and the **Sustainable Forestry Initiative (SFI)**. Both provide companies with a level of assurance that environmental impacts and social interests are addressed and protected when sourcing wood-derived fiber. FSC has previously certified bamboo supply chains, but has recently undertaken a process of assessment for integrity risks. Further, responsible sourcing certificates or standards may not be available for other alternative fiber supply chains.

The burden is ultimately on the companies utilizing the alternative fiber feedstocks to perform adequate due diligence into their supply chains, and to mitigate environmental, social, and reputational risk. Companies may ask suppliers to confirm alternative fibers are sourced from renewable biomass with sustainability-managed production, that production of the fibers does not destroy critical ecosystems, or that fibers do not result in deforestation or conversion of natural forests.

For additional information on responsible fiber sourcing, see the SPC's guide, **Verifying Responsible Sourcing of Fiber.**

Pulping & Papermaking

During the pulping and papermaking process, important differences in a fiber's physical and chemical properties – like length and diameter, percent of cellulose, hemicellulose, and lignin – influence pulping outcomes and dictate the best applications. Desired package or paper properties will dictate the use of hardwood or softwood fibers. The chart below summarizes the sources, properties, and applications of each. Another key is to ensure the package does not lose any of its required properties, such as a reduction in the strength of the material due to incorporation of the alternative fiber (from Lon notes).



Based on paper grade requirements, it is fairly common to blend hardwood and softwood fibers to achieve the desired paper properties. Recipes can also be created to incorporate alternative fibers like bamboo and bagasse. The challenges associated with alternative fiber incorporation into wood fiber blends or existing equipment depends on the alternative fiber being used.

According to **The Technical Association of the Pulp and Paper Industry (TAPPI)**, bamboo presents the easiest alternative fiber for pulp manufacturers to incorporate since it requires similar equipment and manufacturing conditions as hardwood. Other alternative fibers, such as switchgrass or crop residues, may require different pulping systems. **Since existing paper machines and related equipment are designed for wood fibers, alternative fibers with properties most similar to the wood they are replacing are often preferable from a manufacturing standpoint.**

Popular alternative fibers like bamboo or bagasses can be shorter or weaker compared to the wood fibers they are intended to replace. This may limit the applications of the alternative fibers based on their manufactured properties. For example, alternative fibers may work well in a molded fiber product, but not have the strength needed for papermaking. This is not to say the alternative fibers are bad or unworkable but it is important to understand performance characteristics of the alternative fiber.

Alternative fibers may also provide desirable properties based on their physical and chemical structures. The diversity of alternative fibers available provide substitutes that can be used to create a variety of paper grades.

End of Life

Alternative, non-wood fibers may have different recyclability profiles than wood fiber, and not all non-wood fiber packaging is recyclable. Packaging and paper made from non-wood fiber can vary in physical attributes that can impact recyclability, particularly the length of fibers. Shorter, weaker fibers produced during the repulping process may get lost in screening and result in a low fiber yield for the recycled package, ultimately rendering non-recyclable.

As a result, some alternative fiber formats are recyclable while others are not recyclable. Recyclability of a package utilizing alternative fibers will ultimately depend on the results of third party fiber recyclability testing. Beyond the type(s) and percentages of non-wood fiber used in packaging, the structural format (size and shape), coatings, additives, and attachments can also impact recyclability. GreenBlue defines recyclability with consideration for access to collection, sortation, reprocessing, and end markets). This applies to both alternative fiber and wood fiber packaging. For more information, see How2Recycle's Guide to Recyclability.

Along with traditional wood fibers, alternative wood such as bagasse and bamboo are commonly used in compostable packaging like food serviceware or paper plates. All of these fibers typically pass compostability testing, but organizations should be aware of additives or chemicals added to the package that may render the package unacceptable for compostable packaging. Standard setting organizations such as BPI set rules outlining limits on the chemicals that may be present in certified compostable packaging, including packaging made with non-wood fibers. A key example of this is fluorinated chemicals, such as PFAS, which have historically been used to provide grease and moisture resistance to both wood and non-wood fiber food serviceware.

Recent US legislative and regulatory action at both the state and federal level has taken steps to dramatically reduce and eventually phase out the use of fluorinated chemicals. States such as Minnesota have passed strict legislation mandating commonly-used products must be PFAS free by 2025, while the US EPA has recently designated two types of PFAS as hazardous substances, a move in line with its PFAS strategic roadmap. The USDA announced in Feburary of 2024 that PFAS-containing grease-proofing additives for food packaging are no longer being sold by US suppliers, a result of a 2020 voluntary phase-out commitment by PFAS-producing chemical manufacturers. Key to this is to note that this announcement applies to domestically-produced packaging from US suppliers. Imported wood and alternative fiber packaging may still contain chemicals of concern such as PFAS.

Not all packaging should be designed for compostability. Compostable packaging is best suited for applications where it helps divert food waste out of landfills and into compost bins, reduces food residue contamination on recyclable materials, or replaces non-recyclable packaging. To learn more, refer to the SPC's guide, Understanding the Role of Compostable Packaging in North America.

2. Understanding Assumptions & Tradeoffs

Assumption 1: Alternative Fibers Save Trees

Assumption 2: Alternative Fibers Use Crop Residues That Would Otherwise Go to Waste

Assumption 3: Alternative Fibers are Better for the Environment

Assumption 4: Alternative Fibers are Cheaper

Companies interested in exploring alternative fiber sources for paper and packaging must consider a number of common, but sometimes misguided, assumptions about the impacts of both wood and alternative fibers. For example, many brands turn to alternative fibers based on well-meaning concerns about deforestation from the use of traditional wood fibers. The idea that going "tree-free" saves trees is just one of the common assumptions in this space.

Learning more about these assumptions and the nuances behind them can help companies navigate the tradeoffs associated with sourcing both wood and alternative fiber and make more informed decisions. This section explores some of these assumptions and important considerations.

Assumption 1: Alternative Fibers Save Trees

A common hope for changing fiber sources is that this will reduce pressure on forests by reducing harvesting pressure, thereby protecting forests. There are situations where this is possible. However, inherent within this line of thinking is a disconnect between the positive impact of markets on creating investment in forests, maintaining forests, and even improving forests through stewardship and care. The risk for deforestation is largely geographically-dependent, but wood fiber use for paper and packaging is not often cited as a significant factor in deforestation or forest degradation. Organizations like **Two Sides North America** *and the* **World Wildlife Fund (WWF)** *point to activities like urban development and conversion to agricultural lands for crops or cattle grazing as the main drivers of deforestation.*

Diverse forest product markets, including paper and packaging, can help support private landowner investment in the stewardship of forests through mitigation of wildfire risk, removal of invasive species, or protection of important habitat. The costs associated with forest management activities can be supported by revenue from forest products. Forest products provide market incentives for maintaining, and even increasing, the value of forests, particularly on private lands.

Many regional markets support good forestry practices. This is particularly true in North America due to the dominance of private forest land ownership. Across the United States, roughly 60% of forested lands are privately owned. In the US South, the number of privately-owned forests reaches 80%. Strong, diverse forest markets incentivize the continued stewardship of these lands.

A working forest is often a healthy forest. The process of removing trees exposes the remaining trees to more light and less competition for soil nutrients and helps keep forests in a healthy, productive state. This is of particular relevance as forests across the US have been **growing increasingly dense over the past 20 years**. *High density can make forests more vulnerable to forest fires or insect outbreaks, can reduce forest productivity, and ultimately impact a forest's role in mitigating climate impact.*

Millions of acres in North America could benefit from landscape restoration. Forested lands that have previously been cleared for agriculture or pasture may regrow in a haphazard, ecologically dysfunctional manner. Taking an active stewardship role in their restoration and ongoing management can help create resilient and beneficial forests. ***A significant move away from wood fiber may unintentionally divert resources away from forest conservation and stewardship.***

Assumption 2: Alternative Fibers Use Crop Residues That Would Otherwise Go to Waste

Alternative fibers like bagasse and wheat straw are often assumed to be residues that would otherwise go to waste if not used for products like paper and packaging. By utilizing this "waste", companies assume they are diverting resources and turning them into a valuable product.

In some circumstances, this assumption may be valid. By utilizing agricultural residues, organizations can help create revenue streams for rural communities and disincentive **crop burning**, *a practice that creates large amounts of atmospheric pollutants and carbon emissions and can lead to destructive* **wildfires**. *In regions with diminished or minimal forest resources, use of agricultural byproducts can create local supply chains and offer economic opportunities where they may otherwise have not existed.*

However, it is important to note that agricultural residues are oftentimes not considered waste. Many of these materials have markets outside of paper and packaging into which they can be sold. Bagasse and wheat straw are mainly viewed as livestock feed or as a feedstock for bioenergy and biofuels such as ethanol. In some cases, they can even be used for durable items such as **clothing** *or* **building materials.**

There are also environmental and economic incentives to leave agricultural residues on the land. Using the material as a cover crop or tilling into the land as an amendment can improve soil quality, offsetting the need to purchase and use artificial chemicals and fertilizers.

When a stable market for an agricultural byproduct develops, in some ways it no longer fits the definition of "waste". ***Alternative fiber sources are often being viewed as useful feedstocks for products other than paper and packaging.*** *Organizations should not overemphasize the "utilization of a waste product" story in marketing campaigns unless the waste avoidance can be substantiated.*

Assumption 3: Alternative Fibers are Better for the Environment

Perhaps the most widely held assumption, organizations see the use of alternative, non-wood fibers as a means to reduce the environmental footprint of their paper and packaging. This view may be tied to a comparison of alternative fiber-based packaging to packaging using other materials (e.g., plastics), but there is a belief that using non-wood fiber feedstocks reduces the impact of paper packaging, including packaging created from traditional wood feedstocks.

Life cycle assessment (LCA) is a widely accepted methodology for evaluating the environmental impacts of different materials, products, and processes. materials. LCA is a robust, standardized approach, but it can unfortunately lead to variable results based on methodological decisions and utilized datasets. There may be instances where alternative fiber sources are shown to lower the environmental footprint of a package, but examples of the opposite can also be found.

Climate change (often informally referred to as carbon) is often identified as the environmental indicator category of primary important organizations assessing the environmental footprint of their packaging. In March of 2024 TAPPI published two **LCAs from WestRock** *looking at the environmental impacts of linerboard and corrugated using agricultural residues (i.e., wheat straw and bagasse) and a purposely grown alternative fiber (i.e., switchgrass). Both studies found that replacing virgin and recycled wood fibers resulted in larger carbon footprints, driven by the alternative fiber's need for fertilizer during growth and use of different manufacturing processes.*

This is not to say alternative fibers do not have potential environmental impact benefits compared to traditional wood fibers. While forests have the ability to act as "carbon sinks" via carbon sequestration, fast-growing, alternative fibers such as bamboo have the potential to sequester more carbon and produce higher biomass yields in an equivalent amount of time or using an equivalent amount of space. This must be weighed against the need for increased harvest frequency and soil disturbance or the use of synthetic soil additives such as fertilizers, chemicals that have been shown to have a **large carbon footprint**. *Additionally, mature forests or old growth forests are known to sequester carbon at a* **much higher rate**.

Alternative fibers may also have a negative impact on biodiversity. The homogenous structure of alternative fiber crops tends to support a less diverse range of species compared to forests. Some, like bamboo and arundo, also have invasive tendencies that can threaten native ecosystems. Similar to the discussion of carbon, possible negative ecological impacts must be considered against possible benefits. Perennial alternative fibers like switchgrass may require fewer soil disturbances, which is beneficial for water quality and soil erosion.

Looking upstream, differences in the pulping process can result in different environmental impacts between traditional and alternative fibers during manufacturing.

Alternative fibers typically have a lower lignin content than wood fibers, making them easier to turn to pulp and bleach. This results in fewer chemicals, less time, and lower heat and pressure to separate the fibers. Despite this benefit, low yield and poor pulp drainage remain commonly cited challenges for alternative fibers. Poor drainage equates to slower, less efficient operating speeds, meaning larger washers, more water, or additional additives may be added to mitigate the issue. Alternative fibers derived from agricultural byproducts often contain much higher levels of dirt and contamination than traditional wood fibers, which may necessitate additional washing prior to pulping.

Comparative environmental analysis of traditional and alternative fiber sources can be challenging to conduct due to a myriad of considerations and tradeoffs, ultimately meaning a "silver bullet" for reduced environmental footprint may not exist. Organizations considering the use of alternative fibers in their packaging should put results of environmental analysis in the appropriate context based on methodological assumptions made and not lean heavily into claims of environmental superiority without sound data.

Assumption 4: Alternative Fibers are Cheaper

Many brands look to alternative, non-wood fiber as a means to reduce packaging cost via cheaper materials, particularly in the case of fiber from agricultural residues. Increased demand for fiber-based products, a limited or more costly wood supply, and a surplus of affordable non-wood fiber feedstocks all make alternative fibers potentially appealing. Unlike wood fibers, alternative fibers are typically obtained seasonably. Fiber crops are commonly stored covered in loose piles or bales and tend to deteriorate quickly (especially compared to wood). Alternatively, wet storage is sometimes used for non-woods like bagasse. In either case, deterioration reduces fiber brightness and can impact pulp yield. Careful monitoring and chemical treatments can help protect feedstocks, but the burden of proper storage may remain logistically challenging and costly.

Important to the consideration of comparative cost is another source of wood fiber: recycled paper. While the price of recycled paper materials fluctuates, recycled paper can also prove to be a cost-effective source of fiber input. At the same time, an overall industry move towards fiber-based packaging formats may result in higher prices for recycled materials.

Due to these and other supply chain factors, such as the need to potentially ship light, bulky feedstocks, non-wood fibers may or may not be cheaper than wood fibers. Using both non-wood and tree-wood as fiber feedstocks could improve supply chain flexibility and provide greater protection from market dynamics (like those that influence the supply and price of forest products).

Learning more about these assumptions and the nuances behind them can help companies navigate the tradeoffs associated with sourcing both wood and alternative fiber and make more informed decisions.

3. How Do I Know When Alternative Fibers are a Good Fit?

WHAT ARE THE GOALS FOR ALTERNATIVE FIBER USE?

As we have learned, the use of alternative fibers in paper and packaging comes with a range of considerations and tradeoffs. How, then, do companies make decisions on when to utilize these fibers? Identify the key goals for incorporating alternative fibers into your organization's packaging portfolio and weigh tradeoffs accordingly.

GOAL 1: LOWER THE PACKAGE'S LIFE CYCLE ENVIRONMENTAL FOOTPRINT

A primary goal for sourcing alternative, non-wood fibers should be to reduce the environmental footprint of the packaging. To the extent possible, the goal should be to lower impact across sourcing, manufacturing, distribution, and end-of-life, or to focus on the life cycle phase with the largest footprint. Negative environmental impacts associated with alternative fibers will need to be accounted for and mitigated. Companies should thoughtfully consider alternative fiber use and support it with sound data, rather than turning to the fibers because of perceived environmental benefit.

It can be difficult to find reliable information on the environmental impact of alternative fibers, with LCAs often relying on limited or proxy data. The best source of information will always be primary data from suppliers, including sourcing practices, manufacturing processes, and supply chain distances.

GOAL 2: SUPPLEMENT VOLATILE OR LIMITED WOOD FIBER SOURCES

A major strength of alternative wood fiber sources is their ability to be produced in regions in the US and globally where wood fiber may otherwise not be produced, ultimately providing a possible low-cost substitute to wood fibers. The use of agricultural byproducts that may otherwise be wasted also provides an opportunity to optimize local supply chains. Increasing demand for fiber-based packaging may also have the subsequent effect raising prices for traditional wood fiber pulp, further adding to the opportunity of alternative fibers as a lower cost option. The goal should be to keep forests working where they are working and use non-fiber sources to supplement.

GOAL 3: MAINTAIN RECYCLABILITY AND/OR COMPOSTABILITY OF THE PACKAGE

Any use of alternative fibers should not negatively impact the recyclability or compostability of the package. The shortened fibers of non-wood sources, paired with the use of coatings or additives, may render the package not recyclable or compostable. Companies should be prepared to conduct additional testing to demonstrate the fibers pass repulpability testing for recyclability. Compostability certifications will require that companies test their packages for eco-toxicity implications and not use coatings or barriers with intentionally-added PFAS. The key is to remember that a package made from fiber does not not guarantee that it is recyclability or compostability.

GOAL 4: ACCURATELY MARKET THE BENEFITS OF ALTERNATIVE FIBERS

Alternative fiber sources can be a valuable tool for meeting sustainability and cost-performance goals, and it is understandable that companies will want to share their use of an alternative material with customers and stakeholders. Yet finding ways to communicate the environmental impacts of non-wood fiber in a nuanced but accessible way can be challenging.

In the past decade, messaging used to market many non-wood, alternative fiber products have become increasingly divisive. Forest products industry groups and other players have raised concerns about claims that oversimplify tradeoffs, imply clear environmental superiority over other materials, or assert that using non-wood fiber "saves trees". As Part 2 of this guide demonstrated, assumptions about non-wood fiber may not always be accurate. The reality, as is often the case in sustainability, is complicated and can't always be boiled down to a simple marketing slogan.

When talking about environmental benefits, companies should talk about on-the-ground benefits in their specific supply chain, rather than making general claims about a material's performance, provide reputable citations, and give additional context on websites and social media.

For this reason, companies should ensure their marketing materials are accurate, clearly and prominently qualified, and do not overstate the environmental attributes of non-wood fiber or make comparative claims without substantiation. For example, when talking about environmental benefits, companies should talk about on-the-ground benefits in their specific supply chain, rather than making general claims about a material's performance, provide reputable citations, and give additional context on websites and social media.

It is important to understand the reputational and legal repercussions of consumer confusion and deception. To prevent greenwashing, companies should consider presenting claims to colleagues with different technical and legal expertise to mitigate risk. For additional information and guidance, see the **SPC's position statement on greenwashing** and visit:

US Federal Trade Commission's Green Guides

Competition Bureau Canada's Environmental Claims Guide

4. When You Should Choose Alternative Fibers

There's no straightforward answer for when non-wood fiber will be better than wood fiber - each supply chain will have unique benefits and challenges. Given the many implications that sourcing non-wood fiber can have on a package's environmental footprint, performance, cost, and end-of-life, it can be confusing to apply these factors to the packaging decision-making process. One way to explore the value of non-wood fiber in packaging is to consider the following scenarios where non-wood fiber can be a good fit.

When, or If, Alternative Fiber Supply Chains are Traceable or Certified

Ideally, the supply chains of utilized alternative fibers are certified via organizations like the Forest Steward Council and Sustainable Forestry Initiative. In practice, this may not be available, meaning companies should be able to identify their primary producers, mills, and manufacturers to reduce risk and ensure the fibers are coming from a sustainable source. This is especially important if fiber originates from regions without robust laws and effective enforcement that protects environmental features and social/worker's rights.

Once suppliers are established, companies can begin the process of assessing and mitigating risks. Rather than putting together a list of questions for your suppliers, who may receive dozens of similar lists from other companies, consider engaging in more conversations and listening with an aim to better understand their reality. For more principles for verifying non-certified fiber supply chains, visit: https://vrs.sustainablepackaging.org/

When Alternative Fibers Add Important Strength or Performance Characteristics

Your package may be better able to meet specific performance requirements if it incorporates alternative fibers. This may have additional environmental benefits, such as protecting the product or preventing food waste, that are typically far greater than the environmental challenges of a particular material. Alternative fibers may work better in formats like molded fiber based on the performance characteristics.

When Alternative Fibers Supplement Low-Availability Feedstocks, like Newsprint

Non-wood fiber can be a valuable supplement for other fiber feedstocks that have become less available or more costly to source. For example, molded fiber products such as egg cartons were historically made from recycled newsprint. They rely on equipment that fills molds and drains fibers in a “dunking” process that is different from traditional paper-making processes. As the availability of newsprint has decreased in recent decades, these markets are looking for alternative sources of fiber that are similar to what has been traditionally used.

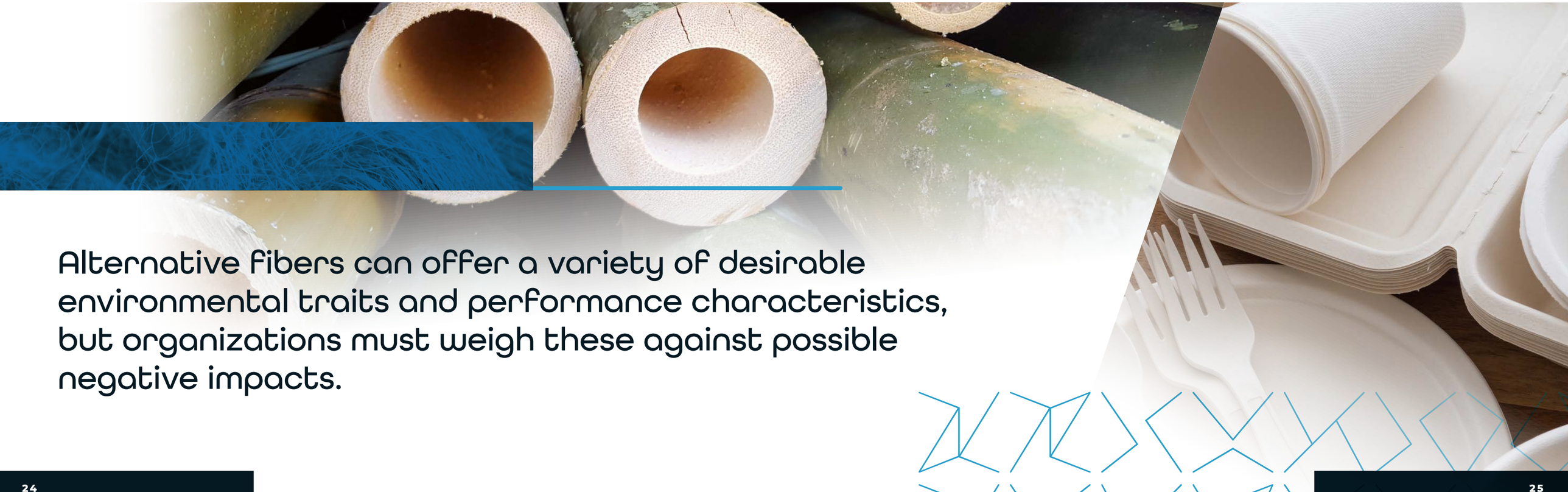
In this case, non-wood fibers with similar performance characteristics to hardwood fibers can therefore be a good substitute. Turning to non-wood fibers allows companies to use similar production techniques and maintain existing manufacturing equipment.

When Alternative Fibers Do Not Impact Recyclability or Compostability

A switch to an alternative, non-wood fiber should not impact the recyclability or compostability of the package. The diversity of non-wood fiber physical properties means package formats created using these fibers may require additional additives for coatings, all of which can impact the recyclability profile of the product. Companies should be prepared to do additional testing to ensure non-wood fiber packaging passes recognized repulpability testing for recycling. Additional certification for compostability, an attribute often sought after in alternative non-wood fibers, will require that companies ensure packages do not include chemicals or concerns or additives that will be problematic in composting conditions.

When Alternative Fibers Reduce the Package’s Environmental Footprint

One of the key assumptions with the use of alternative fibers is they will result in a lower environmental footprint of the package compared to using traditional wood fibers. While this may be accurate in some instances, organizations should utilize recognized methodologies such as life cycle assessment to validate that this is the case. Additionally, results of environmental assessment should be understood in the appropriate context, including assumptions made and proxy datasets used. While climate change or “carbon” is often seen as the environmental impact category of primary importance, considering other categories, such as water use or impact on biodiversity, will help ensure environmental burden is not being shifted.



Alternative fibers can offer a variety of desirable environmental traits and performance characteristics, but organizations must weigh these against possible negative impacts.

Conclusion

The use of alternative, non-wood fibers is not straightforward. It comes with a myriad of considerations and tradeoffs to assess. Some might argue that, if alternative fibers represented a straightforward alternative to wood fibers, these feedstocks would represent a larger portion of the current global pulp supply. In actuality, they still make up a small portion of the fibers used to produce paper and packaging.

The decision of how and where alternative fibers best fit into an organization's packaging portfolio will ultimately depend on the organization's goals. Alternative fibers can offer a variety of desirable environmental traits and performance characteristics, but organizations must weigh these against possible negative impacts. ***Organizations should not lean on common assumptions and support the incorporation of non-wood fibers into their paper and packaging to ensure their sustainable use.***

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