SEEING THE U.S. **INDUSTRIAL HEMP** OPPORTUNITY

A PIONEERING VENTURE FOR INVESTORS AND CORPORATIONS DRIVEN BY ENVIRONMENTAL, SOCIAL, AND FINANCIAL GOALS

From farms to industrial plants, into sustainable goods & nutritious foods.

bioSolutions Initiatives

LEADING THE WAY IN REGENERATIVE FINANCE

FOREWORD

Trailblazing a new industry, opening a new era of agriculture, and creating healthy communities for our families and friends. What is more representative of the American Dream?

This is what our family started in 2018 when we set off to establish the first U.S. large-scale industrial hemp facility in the small town of Fort Benton in central Montana. Undeterred by the stigma and barriers associated with industrial hemp, we saw it for its true potential as a healthy food, a renewable material, and a competitive rotation crop that could bring back hope and opportunity to rural communities. Truly, a catalyst to launch the next industrial revolution that focuses on human health, environmental stewardship, revitalizing rural communities, and creating a better America for generations to come.

This leap of faith represented an investment of almost $40 million into a state that is built on agriculture and value-added manufacturing, which enabled the company we founded, IND HEMP, to create more than 50 good-paying jobs in a very rural area of the country. Not only does this venture show promise financially, but it is also promoting new concepts of land management and soil-regenerative practices across multiple states, including Idaho, North Dakota, Oregon and Washington. IND HEMP and its supply chain partners are creating a new paradigm in which agriculture, manufacturing, and environmental conservation can work together for the benefit of all.

We are not the only ones who see the revolutionary opportunity of industrial hemp. Across the United States, hundreds of entrepreneurs are sharing in the vision of bringing this long-discarded crop to the forefront of the American economy. From Texas to Minnesota, through the plains of Colorado and Kansas, all the way east to Virginia and North Carolina, industrial hemp is being grown by U.S. farmers and used in U.S. factories to manufacture goods that offer superior performance and are better for our planet.

Meeting Pierre Berard gave us the opportunity to sponsor an independent assessment of this nascent industry and to build a roadmap for the future. Pierre came with no prior knowledge of industrial hemp; he was, however, equipped with 15 years of experience in financing small and medium companies in developing countries, particularly in agriculture. As he described it to us “this industry feels like a developing country”. That is indeed where we are.

The infrastructure is being built, the workforce is being trained, markets are being created, and the regulations are being changed to make way for an industry that can fundamentally alter the way agriculture is done in the world. While financial institutions are just starting to better understand the opportunities hemp can deliver, those of us who understand that wealth is not something that is hoarded in a bank but is shared within a community know that the future will hold each of us responsible for what we did or did not do when leadership and action were called for.

We see this report as a great first step in outlining a roadmap to success for this new agro-environmental industry. Pierre provides us with the opportunity to learn more about the great potential industrial hemp has here in the United States and how this industry can be scaled to meet the needs of the environment and growing populations around the world. With hard work that is grounded in American agriculture, along with financial resources and courage that have built the greatest economy the world has ever seen, we are confident that hemp can help change the world and make it a much better place for our children and their children wherever they choose to live.

We are grateful that Montana's legislators and representatives have supported this promising industry since the introduction of the pilot program in 2014, and we are encouraged that other states have enthusiastically embraced industrial hemp as well. The plant represents an immense opportunity for hard-working farmers and rural communities throughout the United States. Ultimately, industrial hemp is a generational investment in rural communities throughout the country while promoting a way of life that respects nature, where families can stay healthy and thrive, and where the hardworking American people can continue to chase similar dreams that have always inspired our greatest leaders.

We wish to see each and every industrial hemp trailblazer across the United States realize their vision. Let us all, government officials, legislators, investors, corporate leaders, and community leaders, help open the doors to this great opportunity.

Julie and Ken Elliott
Founders, IND HEMP

PREFACE

The world is changing, and we find ourselves at a crossroads. Will we work with or against Mother Nature? Will we leverage the amazing resources that are in plain sight? Or will we continue to work against nature and just extract what we need until all available resources are exhausted or compromised?

I was reminded recently how much scientists have drawn inspiration from the natural world. In the late 1990s, Japanese engineers modeled the Shinkansen bullet train after the Kingfisher birds to solve one of their biggest problems: the highly disruptive sonic booms generated when going through tunnels. The new design also reduced the train's energy consumption by 13% thanks to 30% less air resistance.

Another great example is Velcro, the versatile hook-and-loop fastener used in so many aspects of modern life, from disposable diapers to the aerospace industry. After taking his dog for a walk in the woods, Swiss engineer Georges de Mestral discovered that burrs from the burdock plant had attached themselves to both his pants and his dog's fur. De Mestral then spent 14 years replicating what he discovered under his microscope before launching Velcro in 1955.

These two applications of biomimicry – *emulating Nature for the purpose of solving complex human problems* – make me hopeful that we can solve the current challenges facing humanity if only we care to harness the gifts that are available to us.

One such gift is the hemp plant, and we can do much good with it.

Natural fibers were relegated to second fiddle with the advent of the petrochemical industry, which produced incredible innovations that now permeate our daily lives: synthetic textiles, Teflon, plastic, and so on. Even cotton struggled to remain relevant at some point.

The trend is reversing. Industries are rediscovering or, in some cases, pioneering the use of natural fibers for their specific attributes (durability, light weight, resistance, etc.) and because the sustainability imperative appears to no longer be an option. Hemp is one such fiber, the least explored, and probably the one with the strongest potential. But hemp is not only a fiber; it is also a grain with high nutritional properties. An additional blessing of hemp is that it qualifies as a regenerative plant: it is good for soil health and water retention and is one of the highest CO_2 sequestering plants we can grow at scale.

What can we learn from this gift of nature? How much can we change the world for the better with this plant?

This is the journey I invite you to accompany me on. We have the opportunity to launch a new industrial revolution where we can produce nutritious foods and, at the same time, bio-based materials that will complement and sometimes displace synthetics while regenerating our depleted soils. To realize this immense shift, we need businesses, farmers, financiers, and governments to commit to a vision of success that balances the financial, environmental, and social equation for all. I hope this report will convince each of you to join me in this worthy enterprise.

Pierre Berard
Impact investor
bioSolutions Initiatives

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DISCLAIMER

The industrial hemp sector is nascent, multi-faceted, and changing rapidly. We tried to provide as comprehensive an assessment as possible, although we do not pretend to have been exhaustive. The timing, numbers, and projections contained in this report are preliminary figures that reflect the current state of the analysis.

This report is meant to be a working document for the development of the U.S. Industrial Hemp value chain and for bringing capital to fulfill the potential of the industry. As a result, it will be amended from time to time.

As we delve into more details and include more complexity into the financial modeling, which is part of the Next Steps described in *Section 10* of this report, these figures will be updated.

Please send any inquiry or comment to pierre@biosolutionsinitiatives.com

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Executive Summary

THE PROBLEM

As population growth increases the demand for housing construction, clothing manufacturing, food production, and water utilization, the viability of our current production model appears more and more fragile. Between 20 and 40% of the global land area is degraded or degrading, water scarcity is rising while polluted water is now widespread, the abundance of petroleum-based manufactured goods is creating unimaginable amounts of waste, and greenhouse gases keep increasing.

Fortunately, a growing awareness among consumers, governments, and corporations has led to the emergence of powerful trends trailblazing alternative models of development, production, and consumption. The circular economy, bio-based materials, short supply chains, plant-based foods, and regenerative agriculture are five major trends that aim to respect the planet's boundaries by minimizing material extraction, energy use, and environmental pollution.

IMPERATIVES

Investors and corporations are realizing that sustainability now drives business resilience, competitiveness, and capital attractiveness; to "future-proof" growth, they have made ambitious commitments to reduce their reliance on traditional materials, production techniques, and systems. **However, this new race to achieve sustainability is bound to face bottlenecks as the supply of sustainable materials is insufficient**, leaving many industries that are particularly exposed to supply chain disruptions, reputational risks, lawsuits, or regulatory changes in a particularly vulnerable position.

THE SOLUTION

Industrial hemp is an agricultural crop that can generate both sustainability and product performance for multiple industries. As a sustainable cropping alternative, the plant is highly regenerative for soil, improves water retention, boosts yields on subsequent crops, and sequesters tremendous amounts of CO_2; moreover, its uses as a biomaterial and ingredient across multiple sectors like plastics & composites, textiles, pulp & paper, construction, and nutrition magnify its sustainability value. On the performance side, industrial hemp contributes its strong attributes to many diverse applications: light weight for plastics, durability and stiffness for composites, insulation and fire resistance for construction, and extremely high nutritional content as human food and animal feed.

OPPORTUNITY

After 80 years of legal prohibition, U.S. industrial hemp is small, nascent, and decades behind that of countries like China, Canada, and France, but it could flourish into a $2.2 billion annual revenue industry by 2030 and create 8,166 jobs. Indeed, the U.S. landmass allows for much larger farming operations capable of supplying different industries at scale, and as second-movers, American companies can benefit from other countries' experiences and more mature technologies, as well as a wide diversity of investors and deep financial markets.

Building an industry based on an agricultural crop is complex and takes a significant amount of time, usually decades. The soybean industry took about 50 years to become firmly established, from the first UDSA imports in 1898 to the U.S. being the top worldwide producer in the 1950s. France's industrial hemp value chain, which is now ranked as the world's 3rd largest producer and is probably the most diversified, started in the late 1960s.

GOAL

We believe the possibility exists to accelerate the development of U.S. industrial hemp, and the process comprises four pillars. First, the cornerstone of the industry is a strong partnership between farmers and industrial processors at the local level. Second, the industry needs a federating body that will represent it, foster markets and innovations, and reduce risk for its members and investors. We call it the Sustainability Alliance. Third, collaboration with corporations that aim to secure or diversify their supply chains with sustainable products and enhance their ESG credentials will be key to funding the industry and creating markets. Fourth, significant amounts of funding – over $1.6 billion for the next seven years – from the government, corporations, investors, and philanthropic donors will be necessary to successfully establish the industry. Embedded in these four pillars is an even more favorable policy framework that is still evolving.

ROLES

As a farmer, manufacturing company, corporation, investor, donor, or government body, how do you participate in making this new industry a success? Realizing the U.S. industrial hemp opportunity will require action at all these different levels, with the promise of generating positive environmental, social, and financial returns.

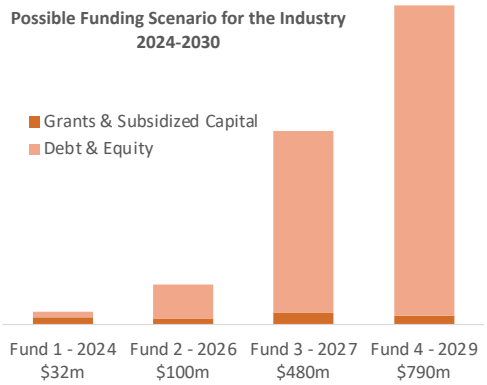
- **Farmers** have an opportunity to use industrial hemp as a crop rotation for weed control and disease control (e.g., Midwest corn and soybean farmers who struggle with glyphosate-resistant weeds) or as a risk mitigation crop in drought areas (e.g., Texas cotton farmers). Beyond that, the plant has regenerative attributes for the soil, which in turn improve yields on subsequent crops like wheat, soybeans, corn, sugarbeet, etc. Combined with a lower chemical input need, industrial hemp should offer a positive margin to farmers with a stable price year after year since it is not traded as a commodity. Finally, farmers can work closely with the industrial hemp processors in their area for mutual gain, including profit sharing and the revitalization of rural areas and small towns through job creation.

Patrick Brown, a fourth-generation farmer in North Carolina, started growing industrial hemp in 2017 and has been a very strong advocate since then. Thanks to introducing hemp as a rotation crop, he saw yield improvements on his soybean production of over 20%, as well as better erosion control.

- **Entrepreneurs and existing manufacturing companies** can take advantage of the rising demand for biomaterials and sustainable goods. They can choose to become primary processors of industrial hemp and work closely with farmers, or they can become secondary processors by including hemp byproducts in their materials or ingredient formulations.

French company APM, a secondary processor and joint venture between Forvia (the 7th global automotive supplier) and agricultural cooperative Interval, has been equipping cars with its NAFILean product for over 12 years. NAFILean is 20% hemp fibers reinforced polypropylene compound designed for automotive structural parts by injection process (dashboards, panels, etc.). The weight reduction gain is up to 25% with a positive environmental impact, validated by a Life Cycle Analysis.

- The industrial hemp value proposition is wide enough to appeal to **investors** with various goals, whether they favor financial return, social impact, or environmental benefits. Philanthropic capital will be catalytic in starting up industry-wide initiatives, ventures, and in de-risking this nascent industry. Equity and debt investment opportunities are available at different levels of the value chain: farmers will need machinery and working capital, which can be secured by land or hard assets; processors will need significant capital expenditures and a decent amount of working capital that can be backed by inventory, trademarks, patents, or hard assets; seed companies that are developing new varieties will generate valuable intellectual property; and so on. Assuming the launch of an investment fund, not all funding would be needed at once and would be staggered; given the nascent state of the industry, a large and dedicated vehicle might be too risky in terms of concentration risk. Proving the investment thesis can be done by one or several smaller funds, which will then be repeated and grown to larger sizes.



Toyoshima & Co., Ltd., a $1.38 billion global textile powerhouse headquartered in Japan, has embraced the U.N. Sustainable Development Goals and promotes the use of organic cotton, traceable and recyclable resources, and respect for the forest and marine environments. In 2023, as part of its goals to deliver sustainable products to environmentally conscious consumers, the corporation became the lead investor in FyberX (Virginia), a new industrial hemp processor focused on textile production.

- **Corporations** can position themselves to be early adopters or investors in industrial hemp, thereby diversifying their supply chain, meeting the growing demand for sustainable goods, or simply augmenting existing products thanks to the plant's attributes. As regulatory pressures for decarbonizing industries and meeting ESG goals in Europe increase and will likely follow in the U.S., participating in the sustainability race appears to no longer be an option.

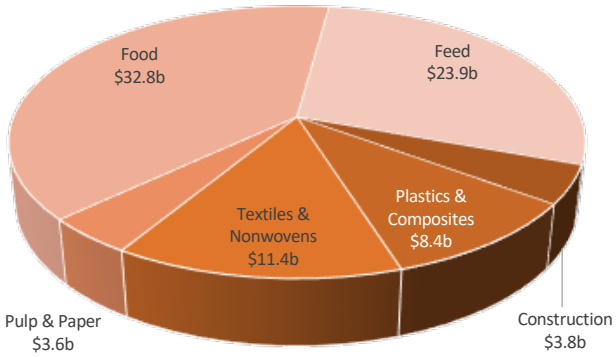
- Securing **government funding and tax incentives** will be important to kick-start the industry. There is significant federal funding for infrastructure, renewable energy, and climate-smart agriculture, as well as tax incentive programs at the state level. Seeing continuous and growing support from government bodies, along with favorable legislation, will be critical to establishing a solid foundation for industrial hemp in the U.S.

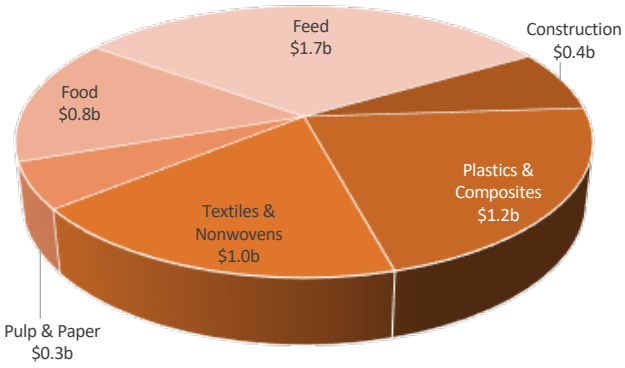
The U.S. Industrial Hemp Opportunity in a Few Numbers

We provide here an outlook for the industry. Please note that this is one of several possible scenarios and that the work to assess the financials in more detail is an ongoing effort. Please refer to *Section 6* for an overview of the development model we are proposing and to *Section 10* for more information on the immediate steps to realize the industrial hemp opportunity.

U.S. Total Addressable Market 2030
$84.0 billion

The largest addressable sectors are in food, animal and pet feed, textiles & nonwovens, and plastics & composites. The six priority sectors we identified are growing at an average of 3.21% per year. See *Section 3* for the summary table and *Appendix 10* for the full assumptions.





U.S. Serviceable Addressable Market 2030
$5.31 billion

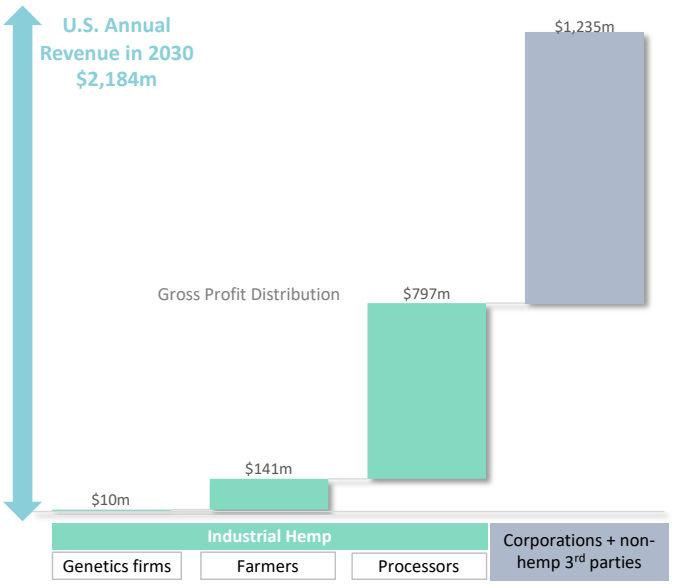
The 2030 Serviceable Addressable Market will represent only 6.32% of the $84.0 billion Total Addressable Market, leaving ample room for future growth. Feed, plastics & composites, textiles & nonwovens, and food represent the largest opportunities. However, the readiness of each market is on a different timeline.

U.S. Annual Revenue in 2030
$2,184 million

By 2030, we forecast the U.S. Serviceable Addressable Market to generate a combined $949 million in gross profit for industrial hemp farmers, genetics firms, and processors.

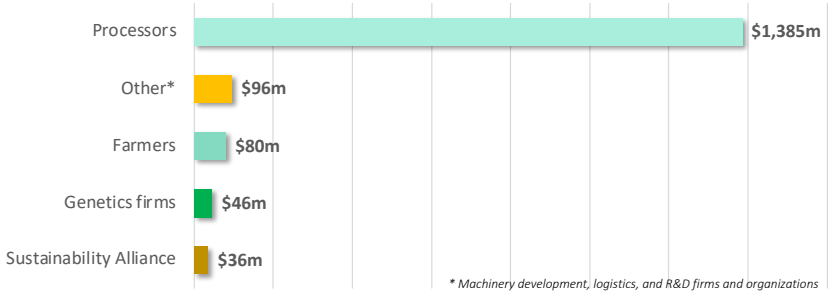
As industrial hemp will be *blended* with other materials and ingredients, the multiplier effect on value-added products is significant.

Which is why an additional $1,235 million in gross profit will be generated through manufacturers, distributors, non-hemp suppliers and third parties.



Cumulative funding needs to 2030
$1,642 million

Reaching $2,184 million in revenue by 2030 will require $1,642 million to establish and grow the industry during the period 2024–2030.



The ambition to start up this nascent industry will benefit from a blended[a] capital approach: philanthropic grants, equity, debt, and government funds should be combined to achieve an optimal return, risk, and impact outcome.

A Government contribution of at least $240 million – through grants, tax incentives, and other subsidies – will be necessary to generate a sufficient ROI for private capital, reduce risk for entrepreneurs, and mitigate the adoption cost for farmers. This contribution would represent only 14.6% of the total funding.

Note that the stated funding figure encompasses industrial hemp genetics firms, farmers, and processors as well as the supporting structure (the Sustainability Alliance, R&D efforts from private actors and universities, logistics, etc.). It does not, however, include investment at the corporation level, for example, for manufacturers who will purchase from industrial hemp processors for their own products. Investments at that level will likely be needed.

Beyond 2030, we believe investment opportunities will become more numerous and larger as the industry attains scale and volumes grow.

Impact by 2030

1,250	farmers growing hemp as a rotation crop, with 10-20% increased yields and incomes on subsequent crops (wheat, corn, cotton, soybeans, barley, etc.)
8,166	U.S. jobs created, for a total payroll of $454 million (*see Appendix 9*), mainly in rural areas
151,000	acres under cultivation - over 8x today's area - benefiting from the plant's regenerative attributes
Over two	million tons of CO_2 sequestered in the plant; additional carbon will be sequestered in the soil
736,000	pounds of glyphosate cut (i.e., 334 metric tons)
Thousand tons	of petroleum-based and harmful materials substituted through industrial hemp in manufactured goods, reducing manufacturing pollution and end of life waste

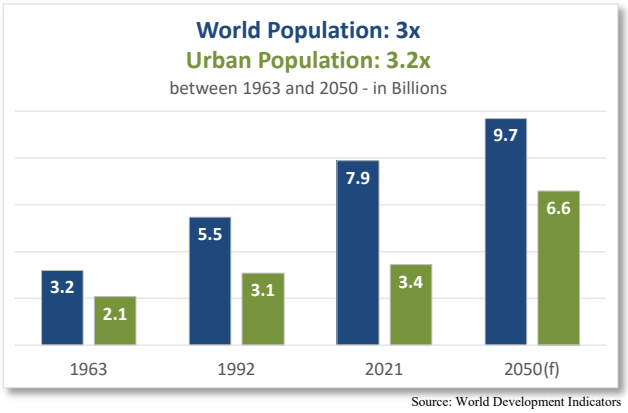
[a] Blended finance is the use of catalytic capital from public or philanthropic sources to increase private sector investment in sustainable development.

1. Our Current Production Model is Trapped in a Destructive, Vicious Circle

1.1 Population Growth Brings Unprecedented Challenges

By 2050, global population growth will require more housing construction, clothing manufacturing, food production, and water utilization. Moreover, unprecedented urban growth combined with a rising middle class, notably in developing countries, will shift millions from smallholder farmer/producer activities to net consumers and raise demand for manufactured goods and services overall.

However, the current production model appears unsustainable.



Source: World Development Indicators

Between 20 and 40% of the global land area is degraded or degrading[1] due to the cutting down of forests for timber or food, urban expansion, mining, infrastructure, desertification, and agricultural intensification[2]. Agricultural land, estimated to be 52% degraded, is suffering from the intense pressure to produce food, fiber, and energy; long-term soil fertility is on the wane around the world due to salinization, acidification, erosion, and the loss of important nutrients in the soil such as nitrogen and phosphorus. Degradation has an economic cost and long-term consequences. Farmers offset these losses with fertilizers, also intended to boost yields, but the cost cuts into their margins while nutritional qualities worsen; the environmental impact of fertilizers compounds degradation, meaning that the pursuit of food security through higher yields will eventually hit a wall.

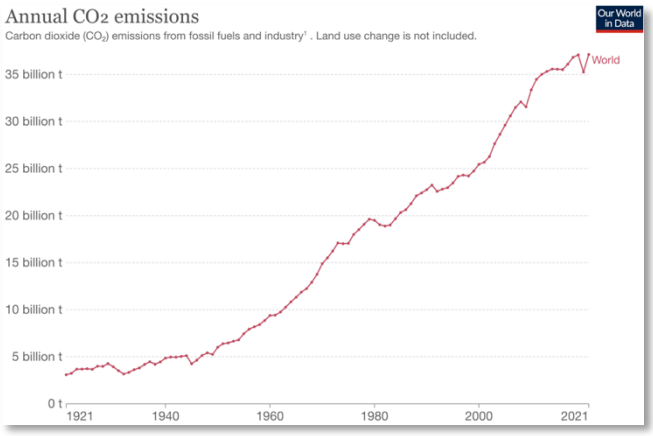
Water scarcity is rising, and polluted water is now widespread. The vast majority (roughly 70%) of the world's freshwater is used for agriculture, while the rest is divided between industrial (19%) and domestic uses (11%), including drinking. In the U.S., irrigated agriculture is the primary user in most water basins, often accounting for over 75% of annual consumption[3]. For example, the Ogallala aquifer, a vital U.S. water source, is rapidly declining. More than 27% of U.S. cropland lies right over the aquifer, which supplies 30% of the groundwater used for irrigation in the U.S. In addition, it is critical for the drinking water of eight U.S. states in the middle of the country. The intensive model of agriculture that relies on chemicals also affects the quality of water sources through runoffs: fertilizers stimulate algal blooms and affect the ecology of local streams; nitrate and some herbicides can move through the soil to groundwater and, eventually, to local streams; ultimately, chemical runoffs from agricultural activities and eroded soil empty into estuaries and may negatively impact valuable fisheries[4]. For example, at least one pesticide was found in about 94% of water samples, in more than 90% of fish samples taken from streams across the U.S., and in nearly 60% of shallow wells sampled.

Most modern manufactured goods are petroleum-based. Over 6,000 common products[5] use petroleum feedstock in their formulation and production, from clothing to food preservatives[6], hand lotions and shaving creams, dyes and paints, and, of course, plastics. Those products are not biodegradable and are currently difficult to recycle. As much as 26% of global plastic production is used for packaging, of which single-use plastics account for 50%. Only 5% of U.S. plastic waste was recycled in 2021; the rest ended up in landfills, in the atmosphere as tiny toxic particles, and in the oceans (like the Great Pacific Garbage Patch, an area 1.6 million square kilometers wide – 620 thousand square miles – consisting of 45–129 thousand metric tons of plastics)[7]. The prevalence of petroleum-based products in our daily lives and their impact on health are much debated. Nonetheless, it is concerning that "forever chemicals" (i.e., PFASs - perfluoroalkyl and polyfluoroalkyl substances) are now found in U.S. drinking water[8] and in human blood[9].

So huge is the amount of waste generated by manufactured goods that advanced economies export it to emerging markets. Europe and the U.S. export most of their waste to lower-income countries in Africa and Asia, notably Indonesia and China, where it is dumped and only partially recycled[10]. For the period 1988–2016, the EU ranked as the main exporter of plastic scrap, followed by the U.S., with a combined volume of 93.45 million MT, the

equivalent of 10 Empire State Buildings a year[11]. Obviously, transporting, processing, and dumping those million metric tons of waste contributes to water, soil, and air pollution, as only 9% of plastic waste is recycled globally[12].

Greenhouse Gas (GHG) emissions, of which carbon dioxide (CO_2) represents almost 80%[13], keep increasing. In the past hundred years, worldwide emissions of CO_2 have multiplied 12 times. The gas enters the atmosphere through the burning of waste, fossil fuels (oil, coal, and natural gas), trees, and other biological materials, as well as certain chemical reactions (e.g., cement production). Approximately 40% of global GHG emissions can be attributed to buildings' construction, use, and demolition[14]. As part of the biological carbon cycle, plants absorb CO_2, removing it from the atmosphere (or "sequestering" it). In 2021, the U.S. was the second-largest emitter of CO_2 with 5 billion tons, behind China at 11.5 billion tons[15].



Accelerating urban growth is compounding all the trends described above. Urban growth is reducing agricultural land, causing biomass loss, increasing demand for goods and energy, pushing CO_2 emissions upward, driving waste generation upward, and affecting hydrologic cycles.

Clearly, we are in a vicious circle. We need a new paradigm.

1.1 Powerful Initiatives and Trends Seek to Break the Vicious Circle

Multiple worldwide initiatives and trends have emerged that encourage alternative models of development, production, and consumption with the aim of respecting the planet's boundaries in terms of material extraction, energy use, and environmental pollution.

Investors and corporations are realizing that sustainability[b] now drives business resilience and competitiveness. First, businesses that are dependent on raw materials are vulnerable to disruptions, whether geopolitical or climate-related. Moreover, the provision of sustainable goods today is often limited to niche markets, meaning small and highly fragmented supply chains; how can companies thus secure or aggregate supply at scale? Second, consumer goods companies have started worrying about their sales performance given that behaviors are shifting and consumers expect and reward higher levels of proven sustainability in the content of products. Finally, manufacturers are concerned about regulations that would extend their companies' responsibility for the social and environmental costs of their products.

According to McKinsey, corporate action is paramount to driving the world on the path to recovery by 2050[16]. Existing commercial technologies could fully return the world to within the planetary boundaries for nutrient pollution, freshwater consumption, and deforestation. Corporations could also address almost half of the projected gap to the biodiversity loss boundary and up to 60% of plastic and chemical pollution.

We identify five crucial trends.

The circular economy model is a model of economic development designed to benefit businesses, society, and the environment[17]. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources[18]. It is based on four principles: use less (narrow), use longer (slow), make clean (regenerate), and use again (cycle). The global economy is now only 7.2%

[b] Defined here as *how* a company conducts its business, considering all stakeholders, and seeking to address social and environmental issues.

circular[19] and is unfortunately getting worse year after year, driven by increasing material extraction and use. The circular concept represents a major shift in how most product-centric businesses operate today, which is why the buy-in of over 250 major corporations (Blackrock, Danone, H&M Group, Ikea, The Coca-Cola Company, Unilever, Walmart, etc.) sends an important signal.

Bio-based materials could be at the onset of a new wave of innovation known as the Bio Revolution. As much as 60%[20] of the physical inputs to the global economy today are either biological (plants or animals) or nonbiological (cement or plastics), but could in principle be produced or substituted using biological means. Adoption of bio-based materials has been problematic given the highly developed and large-scale incumbent technologies, mainly based on petroleum. However, consumers, regulators, and investors have all been demanding significant actions from corporations, suggesting that there may indeed be, if not a clear and bankable "green premium," then a sizable and fast-growing market for sustainable chemicals and materials. As an example, in 2022, funding for biomaterial startups increased by 15% to $2.3 billion as industries looked for non-synthetic alternatives[21]. The global market for bio-based materials is expected to reach $82 billion by 2028[c], up from 21 billion in 2020[22].

Short Supply Chains are partially reversing the previous era of globalization. Reshoring and nearshoring are on the rise, motivated by a mix of consumer sentiment (U.S.-made preference, ESG consciousness), geopolitics (China decoupling, U.S. government incentives), and more affordable automation (solving labor availability and cost issues). In 2022, 96% of CEOs were evaluating reshoring their operations, had decided to reshore, or had already reshored, an increase from 78% the year before[23]. As a result, U.S. construction spending on manufacturing increased 2.7x to $201 billion over the past 3 years[24]. Since COVID, U.S. imports of manufactured goods from Mexico have grown from $320 million to $402 million (+26%), with many Chinese companies setting up their operations there.

Plant-based Foods are expected to grow faster than traditional foods due to concerns about sustainably feeding the increasing world population. Even before COVID struck, consumers of various demographic backgrounds had been experimenting with conscious eating for health and sustainability reasons. The pandemic accelerated the trend, spurring consumers to eat fresher, healthier food. As part of this, consumers are willing to give plant-based alternatives a try: about 25% of U.S. and EU consumers[25] ate more plant-based products during the pandemic; about 33% call themselves consumers of plant-based products, especially plant-based milk and meat; and another 15% expect to start consuming plant-based products in the next year. The total market size is expected to grow to $162 billion by 2030, from $29.4 billion in 2020 (+18.6% CAGR)[26].

Regenerative Agriculture aims to replace the current extractive system of production with a holistic approach that benefits overall soil health, biodiversity, water availability and quality, animal welfare, community resilience, and livelihoods. Extensive research shows that regenerative approaches can help build soil carbon, which in turn can have positive effects on soil nutrient availability, water holding capacity, system biodiversity, resilience to extreme weather, disease resistance, greenhouse gas emissions, and community livelihoods. But regenerative agriculture does not stop at the farm gate; the values and concepts behind this approach must be carried through the supply chain, all the way up to the boards of corporations and to shareholders and investors at large. Positively, major food and CPG companies have regenerative or sustainable agriculture commitments. The Sustainable Markets Initiative's Agribusiness Task Force[27] gathers Mars, PepsiCo, Bayer, Olam, and other large corporations to accelerate regenerative agriculture. Textiles are also a big focus, which is why Kering, the French luxury group, launched the Regenerative Fund for Nature[28] in partnership with Conservation International. The global regenerative agriculture market size was estimated at $924 million in 2022 and is expected to grow at a CAGR of 15.7% to reach $2.9 billion in 2030[29].

1.2 Still, the Race to Sustainability Has a Resource-Scarcity Problem

As economic actors have made ambitious commitments to reduce their reliance on traditional materials, production techniques, and systems, bottlenecks will inevitably appear as rapid growth in demand will likely exceed supply, intensifying competition and pushing up prices. Among the industries that are particularly exposed to supply chain

[c] For comparison, the U.S. plastic & resin manufacturing industry was $129.1 billion in 2022. Source: Statista.

disruption, reputational risk, or regulatory changes, the following ones may be hard-pressed to meet their commitments:

- CPG Companies – packaging: about 45% of the demand for recycled PET will be unmet by 2025. This will be a problem for CPG companies that have set ambitious recycled PET packaging goals[30].
- Textile industry – sustainable cotton: most major fashion brands have committed to using 100% sustainable cotton by the end of 2025. However, just 21% of cotton worldwide is grown sustainably[31].
- The Built Environment is responsible for approximately 40% of global CO_2 emissions from fuel combustion and 25% of overall greenhouse gas (GHG) emissions[32]. There is strong regulatory pressure to improve the energy efficiency of buildings to reduce energy consumption and to use biomaterials instead of highly polluting cement.
- Paper & Pulp: as one of the largest consumers of industrial process water in the U.S., it is vulnerable to increasing water scarcity; large volumes of contaminated wastewater are also generated during production. However, demand keeps increasing, notably because of the "paperization" of consumer packaging away from plastics[33].
- Food industry: by the end of 2030, PepsiCo will be exposed to a potential climate-related financial risk of $4.4 billion a year (~42% of its 3-year average annual operating profit), coming from its supply chain (primarily Scope 3 emissions)[34]. The key raw materials that compose the company's revenue are corn, palm oil, potatoes, sugar, and wheat. Similarly, McCain estimates the direct cost of climate change to be around $15 million a year due to potato crop failures[35].

How can we facilitate a production model that is circular, regenerative, as local as possible, and based on plants?

2. The Industrial Hemp Value Proposition

"Industrial hemp" or **"hemp"** is defined in this paper as the plant species Cannabis sativa L. but excluding its CBD (cannabidiol, non-intoxicant) and THC (cannabis) applications. *Section 4* describes its history and regulatory status.

2.1 Industrial Hemp as a Solution

Hemp's uses are multiple: grains are excellent for nutrition and personal care products, while the stalks are processed for textiles, construction materials, paper, animal bedding, plastic compounds and composites, and so on. When considering the issues described in *Section 1.1* above, industrial hemp is uniquely positioned to be a force for good.

Issues	Industrial Hemp's Attributes
Agriculture yields decreasing	Ideal for crop rotation on existing farmland (no need for more agricultural land) Benefits are fewer diseases and positive yield impact on subsequent crops
Degraded soils	Enriches the soil, reduces water loss and erosion thanks to deep root system Lower fertilizer and pesticide needs; no herbicides needed Phytoremedial properties Nutritious food containing all proteins, a perfect balance of essential fatty acids, and various minerals
Water scarcity rising	Uses little water and increases water retention in soil Lower chemical use means cleaner water
Higher demand for manufactured goods Increasing waste production	Uses as biomaterial across multiple industries with partial or full substitution Grows in any climate with low maintenance and rapidly (90-120 days) 99% of the plant can be used: processing does not create waste
CO_2 emissions rising	High capacity to stores CO_2 in the soil (22-37 MT per acre) and in the plant Manufacturing of durable goods further sequesters carbon into final products

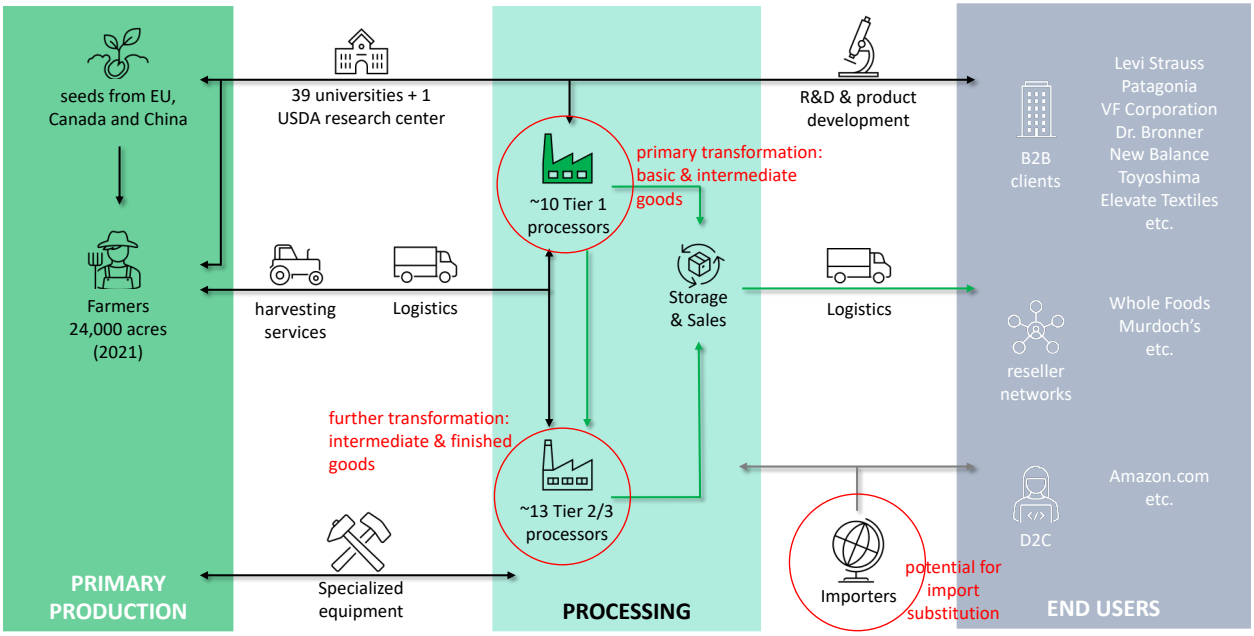
To further illustrate the benefits of industrial hemp:

- *Appendix 1* positively compares industrial hemp to the other main agriculture-based crops and to managed forestry in terms of the Global Warming Potential (GWP), Water use, Soil impact, and Pesticide use. It also describes its strong biodiversity friendliness based on 25 criteria.
- Its capacity to grow across multiple climates and soils (even dry ones) gives it an edge compared to other plants used for biomaterials like bamboo, bagasse, or flax. The possibility of using it in Africa, notably for food production, has been gaining traction. Zambia has an active pilot, and other countries have shown interest.
- The plant crowds out weeds, reducing the need for costly and harmful chemicals. As many as 14 glyphosate-resistant weed species currently affect U.S. crop production areas[36]. The U.S. Midwest is particularly affected since most of the corn and soybean production is concentrated there. When faced with an infestation of such varieties, corn and soybean growers use other herbicides in addition to glyphosate or increase the amount of glyphosate used. Although the USDA and EPA have approved this widely used herbicide, several nations and some U.S. counties have banned it, and the International Agency for Research on Cancer has identified it as a "probable human carcinogen".[37]

2.2 Value Chain

The production and distribution of industrial hemp can be summarized as follows:

- **Genetics companies** breed and commercialize various genetics (i.e., seeds) for food, feed, and fiber applications.
- **Farmers** who grow cotton, soybeans, wheat, corn, etc. introduce industrial hemp as a rotation to diversify their crop portfolio, for weed and disease control, and to enrich the soil.
- **Tier 1 processors** (primary processing) provide farmers with the seeds and purchase the harvest. They process the stalk and grains into **coproducts** and basic finished goods.
- **Tier 2** and **Tier 3 processors** use hemp's coproducts; they can blend hemp into their product formulations to manufacture intermediate goods or finished products.
- **End-users** are corporations (manufacturers or distributors) and consumers served through multiple channels (B2B, B2C, and DTC). Manufacturers will again blend hemp into their own product formulations.

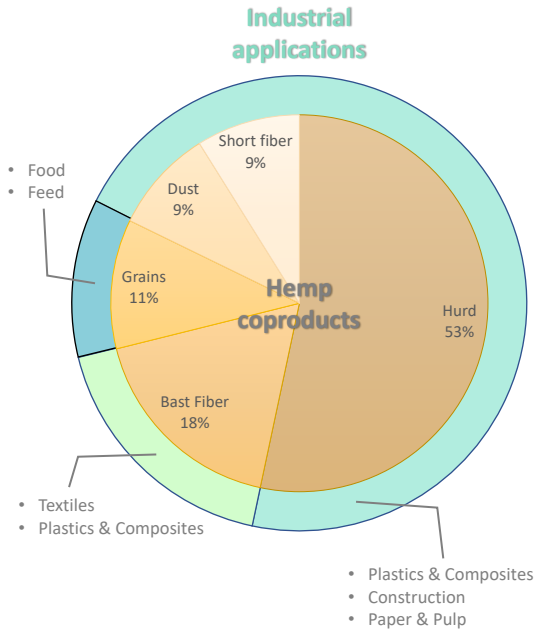


2.3 Applications

Hemp's coproducts are the basis for a wide variety of applications, enabled by the fact that the entire plant can be used without wasting any part of it. For this paper, we do not include the root, which has pharmaceutical uses.

The grain and hull can be used for nutrition, both human food and animal feed, as well as cosmetics. These segments are probably the most accessible, as cultivation, harvesting, and processing are relatively straightforward, as are commercialization and the development of value-add products.

The stalk can be used for its fiber and woody parts ("hurd"), and even the dust from processing has uses. The main applications are in plastics and composites, textiles, pulp and paper, and construction.



Natural and healthy construction and insulation materials are a growing market, and the technology has reached a good level of maturity, although new products are constantly being developed, from structural blocks to rebars.

A huge opportunity are bio-based composites, which can be used with up to a 50% weight gain while offering the same strength thanks to unidirectional fibers. Hemp fibers are also better at vibration dampening than carbon and glass fiber composites (typically 2-3 times better). Composites blend hemp fibers with polypropylene, polyethylene, polyactide (PLA), etc. One common thermoplastic polymer is Acrylonitrile Butadiene Styrene (ABS), which is used for automotive trims and bumpers, inhalers, LEGO bricks, protective headgear, luggage, and more. Hemp can replace it for a 5.3-ton CO_2 gain per ton of material[38].

In paper & pulp, there is huge demand for packaging. With the pressure to move away from plastics, especially single-use, paper-based packaging is facing demand constraints and deforestation concerns. Future applications will be about using the high cellulose content of hemp. Hemp paper is a traditional application and may start a revival.

The textile market holds significant potential but represents a more advanced phase of maturity for industrial hemp. The technology for creating yarns that are usable by current textile manufacturers is still evolving, and promising.

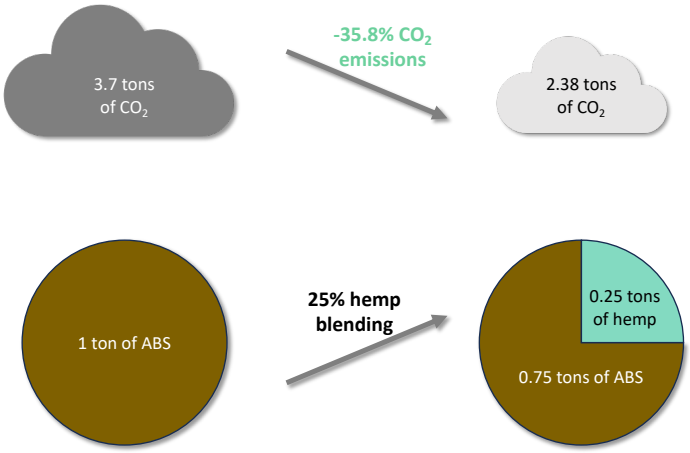
2.4 Improving Industrial Sustainability by Blending Hemp

Industrial hemp meets the definitions for all five crucial trends described in *Section 1.2* above. Its cultivation has strong regenerative properties and can curb or remediate chemicals in the soil; it is a plant that can be used both for nutrition and for biomaterials, making it a perfect resource for a circular economy model; and finally, it fosters short supply chains from farmers to nearby processors and favors a "U.S.-grown, U.S.-made" approach, thus creating positive social and environmental outcomes.

When considering the use of a plant for industrial purposes, the main question is: can we grow it, and how much can we grow? The main plant resources used currently in industrial applications are corn, cotton, soybeans, and wood. All these industries took decades to develop, and today, none are sustainable (see *Appendix 1*).

Nonetheless, this paper argues in favor of blending – instead of fully substituting – synthetic or non-sustainable materials. Gradually combining hemp with other bio- or synthetic materials in the formulation of manufactured goods is the best way to realize its potential. Blending 20% to 40% of hemp improves the sustainability equation in many industries while allowing industrial hemp's production capacity to rise over time.

The graph below illustrates how blending only a quarter of industrial hemp with ABS (the thermoplastic polymer described in *Section 2.3*) would curb CO_2 emissions by almost 36%. The reason is that hemp sequesters carbon instead of emitting it.



tons	CO_2 impact	75% ABS / 25% hemp blend
ABS (emits CO_2)	+3.7	+2.78
Hemp (sequesters CO_2)	-1.6	-0.40
Total CO_2 per ton of material		**2.38**

The hemp industry can bring about significant transformation in terms of sustainability through blending with other materials. Of course, each sector and product will have a different equation, but they all can generate environmental benefits. Beyond CO_2 emissions are the pollution and health aspects as well; more bio-based components in materials will be a step in the right direction.

The attractiveness of industrial hemp is not limited to its sustainable aspect; it also brings tremendous value to final products (lightweight, durable, etc.), opening more possibilities for manufacturers to design high-performance materials. The approach is the same for nutrition: the plant has exceptional nutritional properties and can be combined with other food or feed ingredients. Protein isolates are a tremendous opportunity for that (see *Appendix 6*).

The blending approach makes industrial hemp more attractive to companies. Adopting hemp does not necessarily mean a complete retooling; for many applications, hemp coproducts can be designed to fit into existing processes and machinery. This is a requirement for hemp adoption.

Bedhead Marketing, a Texas-based company specialized in branding for the mattress industry, expanded its activity by designing a process to blend hemp into bedding foam, the HempFoam™. This sustainable material brings performance attributes like moisture-wicking, odor absorption, durability, and breathability at the same cost than the usual synthetics found in foam bedding. Up to 10% of these synthetics can be replaced by hemp, for both a performance gain and for increased biodegradability.

Foams represent a $90+ billion global market and are omnipresent: in automotive (headliners, car seats, arm rests, door cladding, sound proofing), in soft goods (footwear, padded athletic gear, backpack and bags, bras, swimwear, makeup sponges), in homes (mattresses, seats, insulation, fireproofing), in medical (gaskets, sealings, orthotics, dressings, device attachments), and in packaging.

For most applications, the hemp ratio to other materials and ingredients will be between 20% and 40%. This will allow industrial hemp to capture market share progressively without having to ramp up production volumes all at

once. Moreover, since hemp will represent only a part of the final product, it could potentially mitigate the higher price during the early adoption phase until economies of scale kick in.

Sector	Challenges	Industrial Hemp Opportunity	Applications	Impact
Plastics & Composites 	• US recycling rate only 9% • CPG companies have committed to 15-50% sustainable & recycled plastics by 2030	• reduces hydrocarbon use in plastics through partial hemp substitution • makes composites more lightweight (20-25%) and solid • fiberglass substitute • reduces potential deforestation as more agricultural land is used to grow feedstocks for bioplastics	• automotive panels • injection molding • laminated products • foams	• 20-40% hydrocarbon material substitution in composites • up to 25% lighter components reduce vehicles gas & energy consumption • produces 32x lower CO_2 emissions to make than fiberglass
Textiles 	• Over 8,000 chemicals are used by the textile industry, with insufficient transparency • 92M tons of textile waste created annually by the fashion industry will increase by 60% by 2030; US recycling rate only 13.6%; the rest ends up in landfill or burned • Drought threatens US cotton production (Texas)	• hemp needs 55% less water per acre than cotton and yields more fiber per acre • hemp-cotton blends are more durable, reducing waste • hemp can substitute synthetic materials like polyester, reducing CO_2 emissions • Mechanical processing reduces chemical usage	• apparel • footwear • furniture & home furnishings	• Water use vs. cotton: 5.3 Olympic swimming pools saved per ton of spun fiber • Land use vs. cotton: 50% less per ton of spun fiber • Energy use vs. polyester: 3x less • Fewer harmful chemicals improve health and reduce pollution
Pulp & Paper 	• 68M trees are cut down annually in the US (10 football fields / minute) • 50% are harvested for pulp in paper, packaging and tissue • Converting wood into cellulosic fiber (viscose, rayon) is chemical-intensive.	• higher cellulose than wood: 76% vs. 50% • no chemical processing • lower land use and water requirements • hemp for paper is carbon-negative, wood is not	• packaging for CPGs • molded food containers • wipes • nonwovens	• 25-35% substitution in pulp means less deforestation • increase single-use products biodegradability • CO_2 emissions for paper production 78% lower
Construction 	• 39% of the world's CO_2 emissions come from building & construction • cement is the 2nd most consumed commodity in the world (after water) and is one primary CO_2 emitter	• decarbonize the built environment through hemp materials • improve energy efficiency in buildings • no VOC, no health impact	• hempcrete • insulation • hemp rebars • flooring • blocks • decking	• CO_2 emissions reduction • energy savings

Sector	Challenges	Industrial Hemp Opportunity	Applications	Impact
Nutrition: Food 	• soil erosion from unsustainable U.S. practices costs $37.6 billion in productivity losses a year • chronic diseases account for 70% of all deaths in the U.S. Poor diets lead to chronic illnesses such as heart disease, type 2 diabetes, and obesity. American diets are generally poor in nutritional quality. • irrigation and livestock account for 1/3 of freshwater consumption • fertilizer associated with food loss & waste is 14 billion pounds or 44.5 pounds per person, annually	• superfood: contains all amino acids, perfect balance of omega-3 and omega-6, as well as other essential fatty acids, vitamins (A, D, E) and minerals (copper, magnesium, and zinc) • high digestibility • requires less herbicides, pesticides and water • hemp's deep roots prevent soil erosion • yield improvement on subsequent crop rotation of wheat, corn, etc. • phytoremedial ability to pull heavy metals from soil	• proteins powder and isolates • oils • low-calory sweeteners	• improved access to a complete source of proteins, and high nutritional content • water use decrease and higher water retention in soil • curb soil & water pollution • soil health • less fertilizer & herbicides = lower CO_2 emissions protein isolates > Appendix 6
Nutrition: Feed 			• food rations • wellness supplements	

2.5 The Industrial Hemp Value Proposition

Sustainability makes industrial hemp an ideal choice for economic actors by allowing them to:

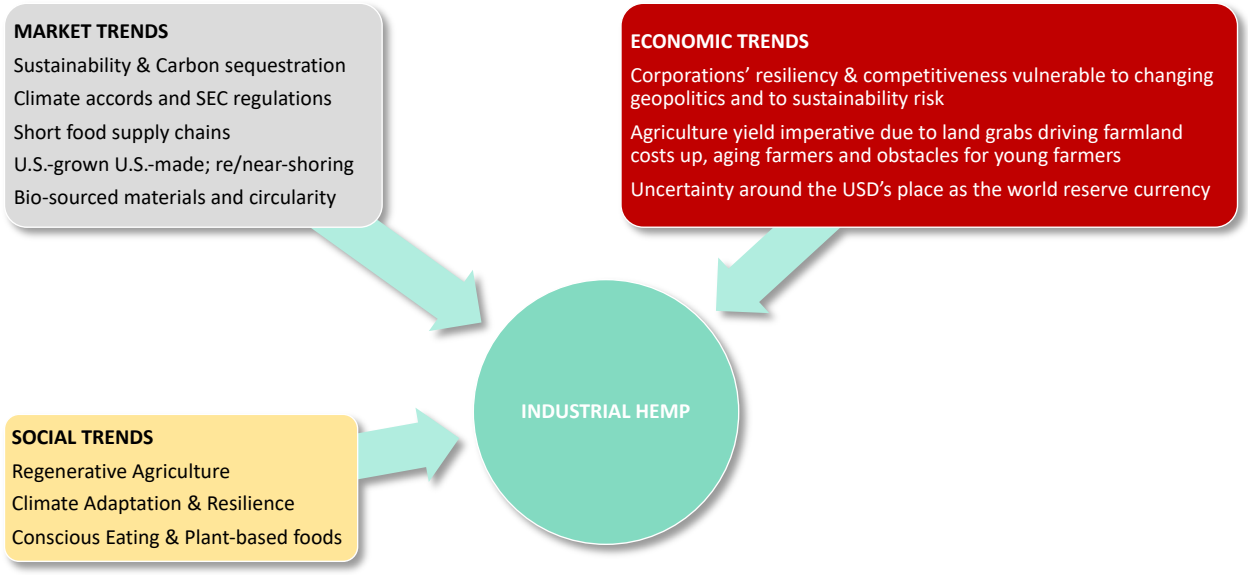
- Produce more to meet the growing demand for goods through a biomaterial that is harmless to the environment.
- Cut CO_2 emissions through the plant's strong carbon sequestration attributes as well as during the production process.
- Reduce the use of chemical inputs, thus lowering soil and water pollution.
- Lower energy and water use during growing and production.
- Improve soils through the plant's regenerative attributes.
- Allow farmers to diversify their crop portfolio with an adaptable and drought-resistant plant that is not a commodity and whose pricing thus does not wildly fluctuate.
- Foster industrial employment in rural areas and plays a role in the U.S. reshoring agenda.

Performance (durability, lightweight, nutrition, etc.) encourages enterprises to partially substitute or blend industrial hemp with other materials (synthetic plastics, cotton, wood pulp, etc.) and ingredients (nutritional oils, cosmetics, protein isolates, etc.) to increase the qualities of their products.

	Financial & Strategic goals	ESG & Impact goals
Investors	invest in the biomaterial industrial revolution "future-proof" investments	meet growing demand for ESG investments in portfolio allocation
Corporations	secure / diversify supply chain meet growing demand for sustainable goods augment existing products	meet committed or regulatory ESG goals de-carbonize supply chain
Farmers	higher yield on subsequent crops cost saving on chemical use more stable prices vs. commodities	soil regeneration water retention weed control

Moreover, **versatility** strengthens the case for industrialization: industrial hemp can be used across many sectors and processed into various products, creating the potential for economies of scale and economies of scope. Therefore, **hubs or industrial parks**, specialized in hemp production and processing, could gather various industries.

Why now? Industrial hemp is at the nexus of today's major trends, which will reinforce its attractiveness.



We expand here on the value proposition matrix for Investors and Corporations:

	Farmers / Agriculture	Tier 1 processors	Tier 2/3 processors
Investors	ESG & Impact goals • reduced chemical use • soil regenerative attributes • CO_2 sequestration • reduced water use and water retention Financial & Risk goals • land value increase • productivity increase (yields) • cost decrease (lower chemical inputs)	ESG & Impact goals • bio-materials manufacturers • de-carbonize industrial supply chains • beneficial impact on farmers / agriculture • nutritious food production Financial & Risk goals • upstream investments, capex-based • lower value-add, volume play • simple intermediate & finished goods	ESG & Impact goals • invest in transformative bio-material applications that will replace synthetic / polluting products in various industries and consumer products • market a rich source of proteins and nutrients to consumers Financial & Risk goals • downstream investments • higher value-add, volume or value • build a portfolio of bio-material applications or products • potentially diversified businesses with lower risk (not only hemp-dependent)
Corporations	**specifically for agriculture chemical companies** ESG & Impact goals • regulations Financial & Risk goals • soil nutrient depletion creates revenue risk; they need to offer solutions to farmers, either through yield mitigation or phytoremediation • weed resistance is increasing, which paired with with rising health awareness, is a risk for revenue	ESG & Impact goals • collaboration with bio-materials manufacturers to develop future products for sustainability Financial & Risk goals • secure / diversify supply chain • develop new revenue streams • full or partial acquisition for vertical integration • R&D and IP in a new way to manufacture	ESG & Impact goals • reduce CO_2 emissions and de-carbonize supply chain (committed goals or regulatory constraints) Financial & Risk goals • substitute with bio-based materials to develop new revenue streams • blend for durability, light-weightness, nutritional content to increase product attractiveness • R&D and IP for brands & products

3. U.S. Addressable Market in Priority Sectors

In 2022, the U.S. industrial hemp *farm production* value was $47.3 million for grain and fiber[39], plus another $41.5 million for seeds. Clearly, the U.S. industry is very nascent and has not yet developed all the potential markets and applications.

We identify six priority sectors that are growing at an aggregate rate of 3.21% per year. From these six sectors, we estimate the 2030 U.S. Total Addressable Market (TAM) to be $84.0 billion, of which $5.31 billion will represent the Serviceable Addressable Market (SAM) by 2030. See *Appendix 10* for a sub-sector view and details on assumptions.

Sectors	US Market Size (b$) current	CAGR	US Market Size (b$) 2030	TAM %	TAM (b$) 2030	SAM %	SAM (b$) 2030
Plastics & Composites	$163.40b	3.53%	$220.76b	3.81%	$8.41b	13.76%	$1.16b
Textiles & Nonwovens	$74.20b	0.69%	$78.70b	14.52%	$11.42b	8.58%	$0.98b
Construction Materials	$80.25b	-0.70%	$75.97b	5.00%	$3.80b	10.21%	$0.39b
Pulp & Paper	$59.54b	2.20%	$72.42b	5.04%	$3.65b	8.00%	$0.29b
Food	$947.30b	3.66%	$1,262.92b	2.60%	$32.84b	2.45%	$0.80b
Feed	$130.70b	3.97%	$194.02b	12.30%	$23.86b	7.08%	$1.69b
TOTAL	**$1,455.39b**	**3.21%**	**$1,904.79b**	**4.41%**	**$83.98b**	**6.32%**	**$5.31b**

4. What is the status of regulation?

Humanity has been using hemp for nutrition and fiber for thousands of years. Hempseeds were found in tombs dating back to the third millennium B.C. in China[40], and roasted hempseed can still be bought on the street as snacks; cultivation for fiber was also recorded there before spreading to Europe in the Middle Ages and later to the U.S. George Washington grew hemp for fiber at his Mount Vernon estates[41].


BILLION-DOLLAR CROP

petition with coolie-produced foreign fiber while paying farmers fifteen dollars a ton for hemp as it comes from the field.

From the farmers' point of view, hemp is an easy crop to grow and will yield from three to six tons per acre on any land that will grow corn, wheat, or oats. It has a short growing season, so that it can be planted after other crops are in. It can be grown in any state of the union. The long roots penetrate and break the soil to leave it in perfect condition for the next year's crop. The dense shock of leaves, eight to twelve feet above the ground, chokes out weeds. Two successive crops are enough to reclaim land that has been abandoned because of Canadian thistles or quack grass.

Under old methods, hemp

(Continued to page 144A)

There were high hopes for the U.S. industry that culminated in a 1938 article in Popular Mechanics magazine dubbing hemp the "Billion-Dollar Crop"[42]. The 1937 Marihuana Tax Act, while generally accused of "banning" hemp, actually made a distinction between industrial hemp and marijuana[43]. Cultivated acres even peaked at around 400,000 during World War II, when the "Hemp for Victory" campaign was launched. The 1937 Act was later repealed in 1970 and replaced by the Comprehensive Drug Abuse Prevention and Control Act, which incorporated verbatim that Act's definition of "marihuana". However, while the 1937 Act used a system of taxation and disclosure that allowed the government to penalize marijuana growers without punishing industrial

hemp growers, the 1970 Act abolished the taxation approach and effectively made all Cannabis cultivation illegal, except where the DEA issued a limited-use permit, by setting zero tolerance for THC. In any case, demand for the plant after World War II, even for industrial uses, decreased as synthetic fibers and cotton largely met the demand.

Interest in hemp reappeared in the 21st century with the trend toward more natural solutions. The change culminated with the 2018 Farm Bill, which authorized the production of hemp and removed hemp and hemp seeds from the DEA's schedule of Controlled Substances. The plant is now regulated by the U.S. Department of Agriculture (USDA)[44].

The U.S. National Hemp Association has advocated that the current regulatory framework makes it challenging for hemp to be integrated into common commodity crop rotations and for the industry to get to scale; to grow hemp, farmers need licenses, background checks, pay fees, and comply with THC testing below a 0.3% threshold. Moreover, each State may have its own regulations.

In March 2023, U.S. Representatives Jon Tester (D-MT) and Mike Braun (R-IN) introduced the Industrial Hemp Act of 2023 (S. 980). The bipartisan House bill was followed in May 2023 by a companion bill (HR 3755)[45] introduced by Representatives Matt Rosendale (R-MT-02) and Chrissy Houlahan (D-PA-06). The proposed legislation addresses the need to distinguish between hemp varieties grown for fiber or grain (i.e., industrial hemp for the purpose of this paper) and those grown for cannabinoid or floral purposes (the CBD and cannabis applications). The benefit of the bill would also remove the need for farmers to do a background check for growing industrial hemp and replace costly sampling and testing with visual inspection checks.

What is the regulatory status in other countries?

The European Union has issued a favorable policy framework and provides subsidies to farmers growing industrial hemp under its Common Agricultural Policy.

Australia, New Zealand, and the UK all have thriving industrial hemp programs and companies.

The United Nations Conference on Trade and Development (UNCTAD) actively promotes the use of industrial hemp for its various qualities: soil health, food security, carbon sequestration, versatility, and income generation.

The Industrial Hemp Act 2023 will certainly be decided upon as part of the Farm Bill in the fourth quarter of 2023 or, at the latest, in the first quarter of 2024. Congressman James Comer, who is chairman of the U.S. House Oversight Committee, has become a co-sponsor of both bills.

Hemp for farm animal feed is another tremendous opportunity that is currently legislated on a per-State basis. A favorable Federal regulation authorizing its use would open a very promising market. Although hemp grain products are generally recognized as safe ("GRAS", an FDA designation) for human consumption and are devoid of cannabinoids (the compound developed by the flower), there is no supporting research in the U.S. (due to historic restrictions), and most studies affirming the safety and efficacy of hemp for human and animal consumption were done abroad. Unfortunately, foreign studies are more difficult to accept by policy advisors and legislative bodies. The Hemp Feed Coalition[46], a non-profit organization composed of industry professionals across animal feed, animal supplements, feed analytics, veterinary science, and hemp industries, is strongly advocating to change this.

There are potential opportunities with state and federal policy to expedite the process, but it is expected that 2-3 years will be necessary to complete the current FDA Center for Veterinary Medicine process to get product approval.

5. Benchmarks to realize the potential of Industrial Hemp in the U.S.

Building an industry based on an agricultural crop is complex and takes a significant amount of time, usually decades. The transition of cotton into the modern age started in the 1960s and took about 20 years, and this was a well-

established industry in the U.S. with factories, markets, and expertise. The soybean industry took about 50 years to become firmly established, from the first UDSA imports in 1898 to the U.S. being the top worldwide producer in the 1950s.

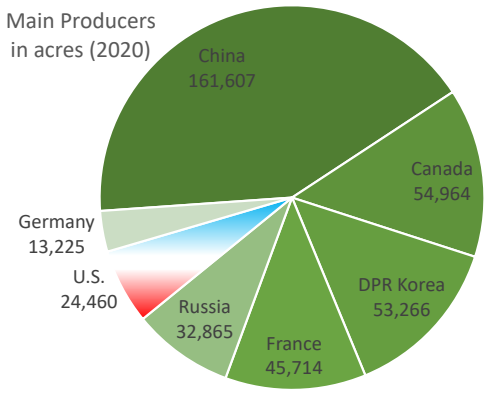
In this section, we look at what can be learned to accelerate the development of this nascent and promising industry.

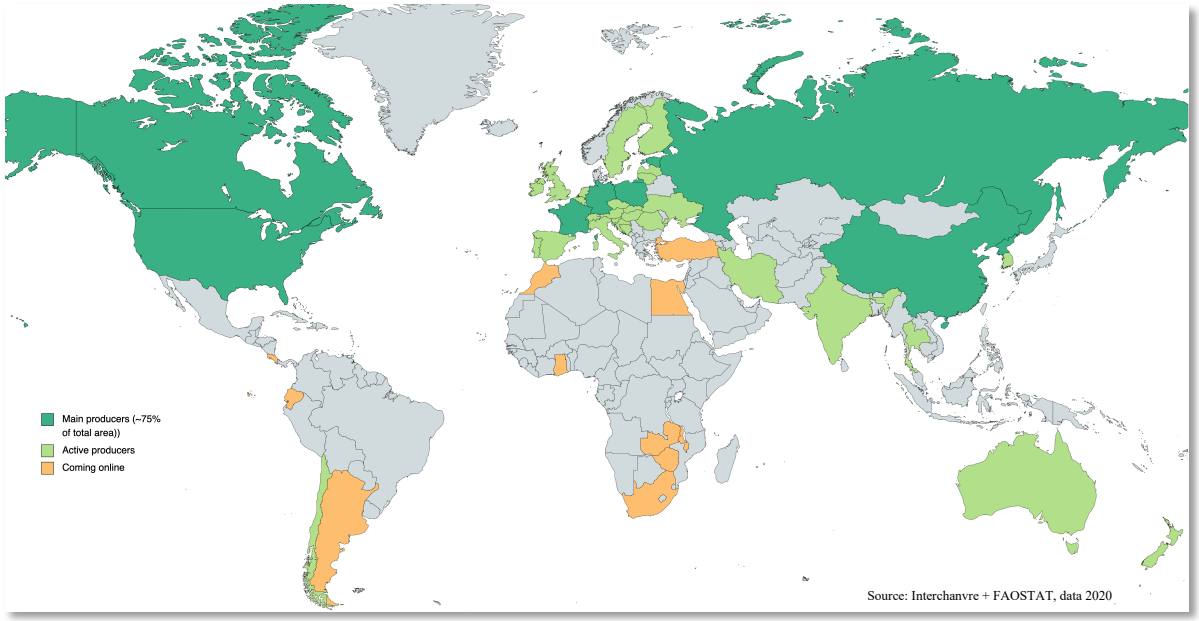
5.1 A Successful Experience Abroad

The main producers of industrial hemp represent over 75% of the cultivated surfaces, with China being the largest (161k acres), followed by Canada (55k acres), North Korea (53k), France (49k acres), Russia (33k acres), and the U.S. (24k acres).

The reason most countries have larger areas is that they never banned production (China) or restarted earlier (France, late 1960s; Canada, 1998).

Today, France has a $100 million revenue industry for a country that represents 5.6% of the U.S. landmass. Canada, which started later and does not have the industrial diversification France has achieved, nonetheless reached $163 million in sales in 2020, mainly on food products.





5.2 Lessons Learned from France, the World's 3rd Largest Producer

From over 435,000 acres in the XIXth century[47], hemp's cultivated areas in France decreased to only 49,200 acres in 2022. While hemp was considered a strategic asset since the XVIIth century (it was used by the French Navy for sails and ropes), the emergence of free trade in the second part of the XIXth century increased the share of imports, and French cultivated areas started decreasing. At the end of the XIXth century, demand was declining as hemp ropes were replaced by metallic ropes, hemp bags by jute bags for goods packaging, and, more importantly, steam engines were replacing sails for marine transportation.

The revival of industrial hemp in France slowly started with the paper industry in the 1970s, then expanded to construction, insulation, and other sectors. In the past ten years, cultivated areas have tripled, and the country is now the world's third-largest producer. France probably has the most diversified industrial hemp value chain in the world, with applications ranging from construction to automotive, including paper & pulp, nutrition, and a growing textile segment. The growth potential, from the development and selection of seed varieties to the final processing, is significant. With little need for irrigation and chemical protection, it fits well into the current consumer demand for healthy food, support for the local economy, and environmental protection.

Several sectors are driving innovation and expansion in hemp. Textiles for clothing and the use of seeds in food are driving demand. Construction is one of the largest growth sectors for France (hemp insulation and hemp concrete), with its main driver being the refurbishing of old buildings with eco-friendly materials (mandated by regulations).

All hemp processors are cooperatives, ensuring that farmers and Tier 1 processors work together. There are six main decortication plants and four under construction.

Industrial hemp in France is eligible for subsidies under Europe's Common Agriculture Policy. Currently, EUR 1.7 million ($1.8 million) is allocated for a maximum of 49,400 acres, i.e., $36.5 per acre. In addition, a sustainability subsidy is also available (from $24 to $36 per acre) based on a threshold of acres dedicated to fallow, rotational, or diversity crops. The total subsidy could thus reach $60-$76 per acre for industrial hemp.
The THC limit is set at 0.3% in France and Europe, the same as in the U.S.

The main observations from France's experience are:

- The cooperative set-up ensured farmers' buy-in and prudent, progressive development. The cooperatives' management teams focused on creating value for farmers; this ensured high rates of farmer retention and enabled the agronomics improvements critical to moving up in product complexity.
- Favorable government regulations, driven by public support, allowed the industry to expand.
- Corporations initially sustained demand, which later fostered innovations and led to one joint venture (automotive parts). Several groups of 3-5 processors came together to pool resources, sometimes with external partners, and established: a) a building trade association with common standards; b) a brand and sourcing platform for cottonized[d] hemp; c) a hemp R&D center that evolved to cover various natural fibers; d) and, of course, a national hemp association to represent, lobby, build alliances, and develop markets.
- France probably has the most diversified industrial hemp value chains in terms of products and markets. However, it took 50 years to get there.
- The main revenues still come from basic products (paper, grains, and insulation) manufactured by Tier 1 processors. The Tier 2 segment is not yet fully developed. As a corollary to this, a whole-plant approach is critical for profitability: no part of the plant can be wasted.

Lessons learned for U.S. industrial hemp:

1. Build strong and long-term Tier 1 processor – Farmer relationships by establishing trust, common goals, and shared interests (price stability, profit-sharing, and non-financial aspects). This is critical to securing supply, improving consistency over time, and developing advanced products through specific agronomics.
2. Fully monetize all the plant's byproducts through a whole-plant approach.
3. Attract investments to multiply and accelerate processors to create redundancy and scale.
4. Encourage the development of a strong Tier 2 network to accelerate demand for Tier 1 products, create industry resilience, and broaden market appeal.
5. Foster collaboration across a few processors to lay the foundations for strategic initiatives, either regional or national, and either industry-wide or segment-specific.
6. Explore strategic alliances with Corporations that are particularly vulnerable to ESG or supply chain risks.

[d] Cottonization is a process that adapts flax and hemp fibers for spinning with other staple fibers such as cotton or wool.

5.3 A quick snapshot of China, the World's Largest Producer

The main observations from the sector are described below.

- Regional specialization: some provinces cultivate only fiber (Heilongjiang), others only seed (Inner Mongolia), while others cultivate both (Yunan, Shanxi and Jilin). Yunan has developed a CBD industry as well. Part of the regulatory framework is regional and is thus not homogeneous. Local protectionism prevents cooperation and exchange of technologies (equipment, genetics, etc.) between the provinces, which probably slows the overall development of the industry[48].
- China has a much higher fiber yield (about double) compared to the world's average and to the major European producers. Some provinces, like Heilongjiang, have been building on their expertise in flax fiber, use a heavily mechanized farming process, and produce high yields.
- China uses three cultivation methodologies: traditional precision drilling with thin planting, high-density dwarf plants, and spring wheat and hemp intercropping. Methodologies adapt to specific topographies; for example, mountainous terrain is more labor-intensive instead of mechanized, which reduces efficiency. The THC limit is set at 0.3% in China, the same as in the U.S. and Europe.
- The intercropping practiced in Inner Mongolia for hempseeds cultivation generates higher yields than monocropping. We have not seen examples of that methodology in Europe or North America.
- R&D accelerated in 2008 with the establishment of China Agriculture Research System (CARS) for Bast and Leaf Fiber Crops, with 20 teams of researchers working all over the country. To note that although the full value chain is covered, end-product R&D has been insufficient.
- The internal market is still nascent and major producers find their revenue abroad in Europe and North America. Product applications and brands are not well developed, the processing infrastructure is limited, and companies are still small. Given China's large population, the potential internal market for nutrition, medicine, and textiles is significant.
- As for the exports market, China still has a cost advantage which can be maintained with better genetics, agronomics, larger farms, and mechanization, and therefore represents a threat to the development of a self-sufficient U.S. industry.

Lessons learned for U.S. industrial hemp:

1. Take advantage of regional specificities to create efficiencies and specialize some U.S. hubs.
2. Regenerative agriculture methodologies, like intercropping, are proven to generate higher yields while improving the soil: can they be adopted?
3. Foster end-product applications through R&D, Tier 2 producers, and Corporate engagement.
4. A U.S. national strategy and collaboration among players in the value chain is critical to success, especially regarding best practices, technology, and market development.

5.4 Lessons Learned from Proven Agriculture-Based Industries

The main observations from the experience of agriculture-based industries are described below.

Cotton: The U.S. cotton industry accounts for more than $21 billion in products and services annually, generating more than 125,000 jobs in the industry sectors from farm to textile mill, of which $6.5 billion is crop value[49]. However, the industry had to face a major hurdle a few decades ago: in 1960, retail sales of cotton apparel and home fabrics represented 78% of all textile products; fifteen years later, cotton's share of the market had plummeted to 34% as synthetic fibers became commonplace, threatening the viability of the cotton industry[50].

- To address this, strong advocacy with Congress secured political support through the Cotton Research and Promotion Act of 1966, which created a funding mechanism for the industry. This ultimately led to the creation of Cotton Incorporated ("Cotton Inc.) in 1970, a research and marketing company working on behalf of the whole U.S. cotton industry.
- Cotton Inc. adopted a dual strategy to regain market share: "push" innovations into the market through product and process development while building consumer demand ("pull") through advertising and

promotion (the "Seal of Cotton" was the first commodity brand). They successfully reversed the trend in the early 1980s.

- In the 1970s, a traceability tool was implemented, followed in the 1980s by a suite of software programs that effectively established an MRP/ERP[e] system throughout the value chain. The system provided better inventory management and analysis capabilities, as well as integrated data exchange between farmers, ginners, mills, traders, and cooperatives.
- Continuous technological improvements on the manufacturing side led to several trademarks, keeping cotton relevant and innovative.
- On the negative side, cotton is vulnerable to drought and highly reliant on irrigation. In 2022, 74% of Texas's, the major U.S. producer, production failed because of heat and parched soil. West Texas is the main source of upland cotton in the United States, which in turn is the world's third-biggest producer and largest exporter of the fiber. The loss could amount to $2 billion to $3 billion. Over the past five years, taxpayers have sent Texas cotton farmers an average of $1 billion annually in crop insurance subsidies, as major portions of the Ogallala Aquifer are now considered a nonrenewable resource and cannot provide sufficient irrigation. The same issue is true in Arizona, which will require an estimated 10% more irrigation than in the past due to increased temperatures to avoid projected future yields of cotton dropping by 40% between 2036 and 2065[51].

Sugar Beet: Sugar beet cooperatives produce between 55 and 60% of all sugar in the U.S., with 1.14 million acres cultivated in 2022 for $1.1 billion of beets, which turned into just over $2 billion of sugar. It is interesting to note that grower cooperatives made up of farmers own all 20 U.S. processing plants. The number of plants is drastically lower than it was in the beginning stages of the industry; in 1927, there were 91 factories across 18 states. Some busts and a major consolidation phase brought the number of processors down.

- Like industrial hemp, sugar beets are difficult to grow and require a high degree of processing.
- Farmers banding together in associations and then purchasing processing plants using a cooperative model enabled the industry's success. This alignment of interests between the farmer and the processing facility was crucial in making the industry successful and profitable: it allowed producers to maintain equity and input throughout the process and receive a higher value through dividends from selling refined sugar; for farmers who mainly sell raw commodities, this was a plus. Moreover, cooperatives can manage specific risks on behalf of their members: controlling production, reducing spoilage, and maintaining high prices.
- Some sugar cane and sugar beet processors allied to establish United Sugars, a marketing cooperative supplying approximately one-quarter of the total U.S. sugar demand.
- What was initially a specialty crop grown regionally evolved to become a national industry represented by the Sugar Association, a trade association for the entire U.S. sugar industry that advocates on behalf of its members, the processor cooperatives.
- The cooperative structure that links growers and processing has the advantage of collecting data that can be leveraged to obtain private insurance at favorable prices.

Soybeans:

- Two main organizations federate the soybean value chain: the American Soybean Association and the United Soybean Board. The former works on state and national legislative and regulatory policy issues; the latter is a checkoff program that aims to create value for soy farmers through research, education, and promotion. As in the case of Cotton Inc., it was a political act that established the United Soybean Board (Soybean Promotion, Research and Consumer Information Act of 1990).
- In 2022, the United Soybean Board's budget was $113 million and served 515,000 farmers. Farmers contribute 0.5% of the market price per bushel as a checkoff to the Board annually, which represented $141 million in 2022. The Board has two Action Teams: one focused on ensuring supply and the other focused on demand.
- Soybeans were one of the first GMO crops to achieve commercial success by becoming herbicide-tolerant following their launch in 1996. In the following 16 years, production increased three times faster compared to the previous 16-year period.

[e] MRP: Materials Resource Planning; ERP: Enterprise Resource Planning

- However, weed resistance to glyphosate has been increasing: 71% of farmers add another herbicide, and 39% increase the amount of glyphosate used, cutting into margins and creating environmental and health concerns.

Lessons learned for U.S. industrial hemp:

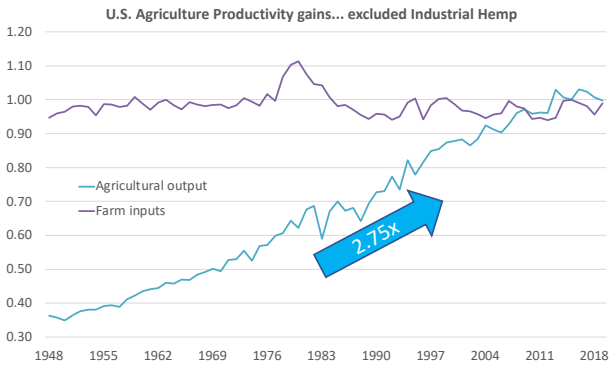
1. The cotton and soybean experiences showed that one or two key representative associations were critical in ensuring their respective industries' success. Today, U.S. industrial hemp has different associations that could benefit from joining under one umbrella, or cooperating more closely.
2. Federate farmers into growers' associations to build up political power and enable better organization with processors.
3. Coordinate farmers and processors with R&D from universities and private firms to "push" innovation and facilitate adoption, possibly with other natural fibers.
4. Generate political support at the state and federal levels to issue favorable regulations and tax regimes, as well as public grants and access to funding.
5. Support data collection, aggregation, and sharing to enable traceability and efficiency along the value chains, facilitate the adoption of common standards, and provide forecasts to third parties (insurance companies, commercial banks, etc.).
6. Explore strategic alliances with industries for 1) complementarity and 2) risk mitigation (ESG or supply chain risks). EX: cotton (Cotton Inc.), forestry (Sustainable Forestry Initiative). Interestingly, cotton gins are very similar to hemp's decortication plants; it is reasonable to assume that the continuous technological improvements that benefited cotton will take place in industrial hemp too.

5.5 The U.S. needs to catch up to the rest of the world… then lead

Following the 1937 Marijuana Tax Act, hemp was placed in a time capsule and missed the most important 20th century innovations, many of which benefited agriculture's productivity.

The 2014 and 2018 Farm Bills reintroduced hemp as an agricultural crop, but as the value chain is restarting, the U.S. finds itself decades behind China, Canada, and France.

We believe the U.S. has the capacity to create a second-mover advantage over other countries. The U.S. can develop industrial hemp faster and grow larger than Canada, France, and eventually China. The timing is favorable due to environmental and societal pressures, and the U.S. is uniquely positioned to take advantage of these trends to establish a lead in this new industrial revolution.



The U.S. landmass allows for much larger farming operations capable of supplying different industries at scale. Moreover, favorable climatology and soils mean that hemp can be grown in nearly all states. France's hemp acreage is comparatively limited (currently 53,621 total acres, averaging 25 acres per farm), while Canada has mainly focused on food coproducts.

Given the current trends in geopolitics that put the supply of fertilizers at risk and considering the social, environmental, and economic pressures to move away from an intensive agriculture model relying on huge amounts of chemicals, hemp should become attractive for cultivation at scale in the U.S. Farmers can benefit from rotating hemp with their existing crops to reduce chemical use, increase yields, and regenerate depleted soils.

Thanks to a potentially larger supply, the U.S. Tier 1 processors will command better economies of scale compared to other countries. This will in turn allow for the provision of competitive products (vs. synthetic and other bio-sourced materials), thus accelerating the adoption of industrial hemp across sectors.

No less than 39 U.S. universities and one USDA research center are investing in industrial hemp. In comparison, France has just a few research centers. The enormous potential in R&D for genetics and agronomics will allow the U.S. to catch up and then innovate.

The U.S. industrial hemp market today is largely meeting the rising demand through imports from China, France, and Canada. Thus, there is potential for import substitution and for creating a U.S.-grown, U.S.-based industry. Levi Strauss's, Vans, and Patagonia's hemp textiles are sourced in Europe and China. One issue for the industry to solve is the ability of hemp to be widely produced at scale to make sustainably produced textiles much cheaper than they currently are and more accessible to a mass market (*see Section 6.3 below*). Re-shoring or near-shoring some parts of the value chain could be a viable option.

As second-movers, American companies can benefit from other countries' experiences, more mature technologies, a wide variety of investors, and deep financial markets. France's main players are farmer cooperatives, where decision-making is prudent and slow and where capital is limited. Technology from abroad can be licensed, and know-how can be imported. Joint ventures can be established with foreign hemp companies.

Products exhibiting traceability represent a huge market opportunity, notably in textiles, through mechanical processing and outsourcing in lower-cost Latin America. Currently, China is the leader in hemp textiles and uses chemical processing (usually highly regulated); U.S. consumers may prefer a product manufactured closer to home and that is chemical-free.

Actively promoting industrial hemp to existing Small & Medium Enterprises ("SMEs") for use in their product formulations has not been actively pursued in other countries and industries during their start-up phases. Fostering the Tier 2/3 processors represents a key element to accelerated development and to building resilience that other countries have not taken advantage of yet.

More broadly, the U.S. combines a large internal market with a high GDP per capita and has one of the highest Economic Complexity Indices[52]. This is why it ranked #2 (behind Singapore) in the 2019 Global Competitiveness Index[53] thanks to business dynamism, innovation, market size, the financial system, and the labor and product markets. The 2023 IMD Competitiveness ranking places the U.S. only at #9[54] but still ahead of industrial hemp competitors like Canada, China, or France. The number of potential applications for hemp can be matched with the diversity of the U.S. economy to create a sizeable, dynamic, and growing market.

6. A Development Model for the U.S. Industrial Hemp Value Chain

Based on the learnings from other industries and geographies and from discussions with numerous people involved with the plant, we propose here the outline of a development model that will enable the industrial hemp value chain to accelerate its development.

Given the inherent complexity of an industry based on an agricultural crop, which is vulnerable to external factors (climate, pests, etc.), involves a variety of different economic actors (farmers, agronomists, factory workers, buyers, etc.), and entails more variance year after year than producing synthetic materials, accelerating should be understood as *faster* but not necessarily *fast*. What took 60–70 years for the soybean or sugar beet industries, we should aim to do in 15–20 years. An industry based on an agricultural product is not a software start-up; economic actors will learn each growing season how to adjust their methodologies, techniques, and tools (i.e., genetics, agronomics, and processing); this iterative process can hardly be fast-tracked.

As a result, we envision the goals of the industry as follows:

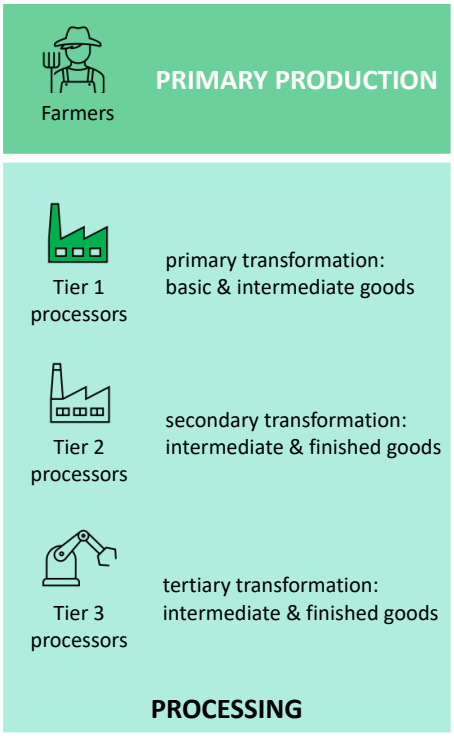
1. Set U.S. industrial hemp on a strong foundation that will allow continued growth and, in some markets, stepladder growth while minimizing busts and booms through resilience.
2. Evolve from the start-up phase to the growth phase by 2030, thanks to sufficient funding, production consistency, and buy-in from corporations.

6.1 Vision: Four Pillars to Anchor the Industry

The optimal matching of supply and demand requires that production and distribution meet the needs of buyers (mainly corporations), and this will be made easier if the industry benefits from some level of federation, or facilitating body, and has sufficient capital runway.

A. Production and Distribution

Production should start at the local level (i.e., State or lower) by multiplying and growing Tier 1 processors while establishing strong relationships with farmers. The relationship between Tier 1 processors and farmers is the cornerstone of the industry; if it fails, the consequences can be disastrous. For the Tier 1 processor, the cost and time involved in building a farmers' network are high. Farmers are quite slow to adopt a new crop, given the risk, cost, and effort involved. Farmer loyalty means having a win-win contractual relationship in place. On the farmer's side, if a buyer (in this case, Tier 1) commits and does not deliver, whether because of business failure, lack of cash, or other reason, it destroys the farmer's trust in the crop and, very likely, in buyers of industrial hemp in general. As a result, the regional farmer's supply may be wiped out for years.



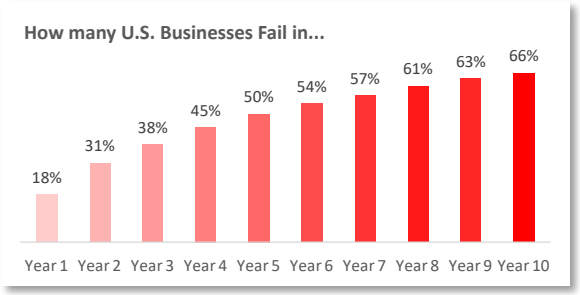
In parallel, it is critical to foster Tier 2 processors to increase demand for Tier 1 and generate cash flow as markets progressively develop. The second Tier of processing converts Tier 1 products into semi- or finished goods. It adds value, scope, and resilience to the value chain. The products marketed by Tier 2 processors will initially be the most visible to consumers and will play an important role in raising awareness about the benefits and capabilities of industrial hemp. Creating brands and doing strong product promotion at that level will likely create a demand pull for industrial hemp in general.

Tier 3 processors are uncommon and will become more numerous as the industry develops and specializes.
Distribution will primarily be B2B, plus a combination of B2C and DTC. The term "industrial" means that industrial hemp's largest market is expected to be with manufacturers using it in their product and ingredient formulations. Nonetheless, blending or substituting hemp in current product "recipes" will take time; B2C and DTC will thus be more rapid avenues to generate cash and develop markets with more basic products. We explore the strategic implications in *Section 8.2*.

B. The Industrial Hemp Sustainability Alliance

The Sustainability Alliance is a collaboration between processors willing to join forces to meet demand in specific markets. We assume that the Alliance will evolve from an informal arrangement between a few hemp actors to a formal organization representing the industry, fostering markets and innovations, and reducing risk for its members.

Given the inevitable risks linked to creating a new industry, having a central body able to support business development, open markets, coordinate the various players, provide tools, and facilitate access to finance will be key to diminishing the number of business failures among all tiers of processors.



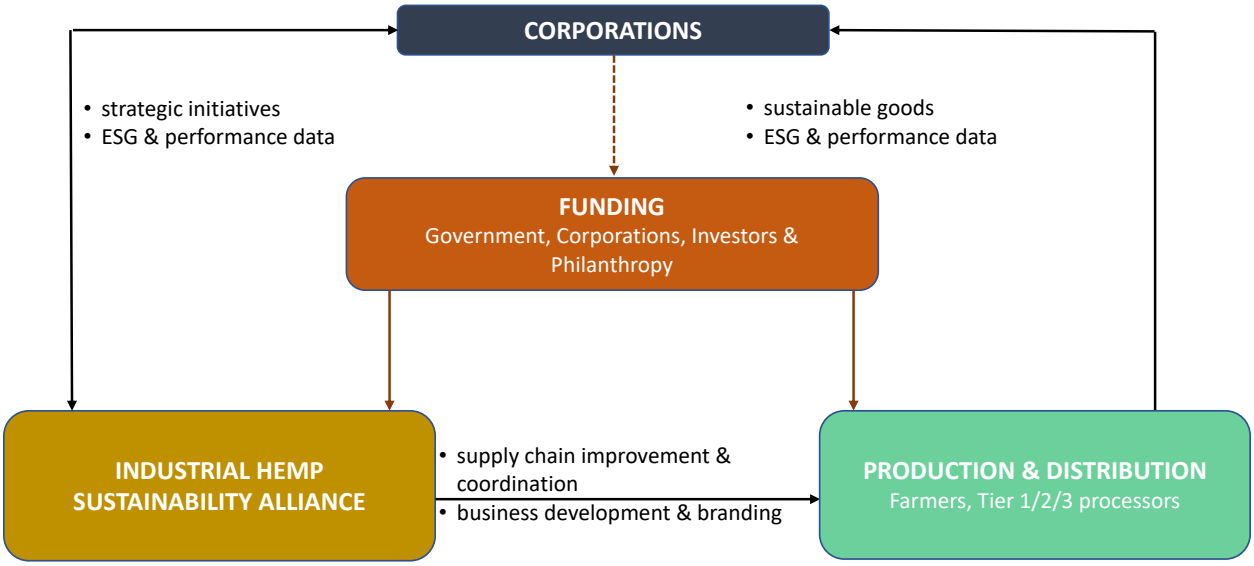
C. Corporations

Corporations desire to secure or diversify their supply chains with sustainable products and communicate their commitment to regulators, consumers, and partners. They will play a role in introducing industrial hemp as an innovation in their existing supply chains, fostering R&D to develop and improve hemp-based applications and products, marketing and securing markets, and funding the industry.

D. Funding

Funding from the government, corporations, investors, and philanthropic donors will be directed to individual companies and farmers and to finance the Alliance's various initiatives.

The chart below summarizes the four pillars and how they interact with each other.



6.2 Multiplying Processors for Redundancy and Resilience

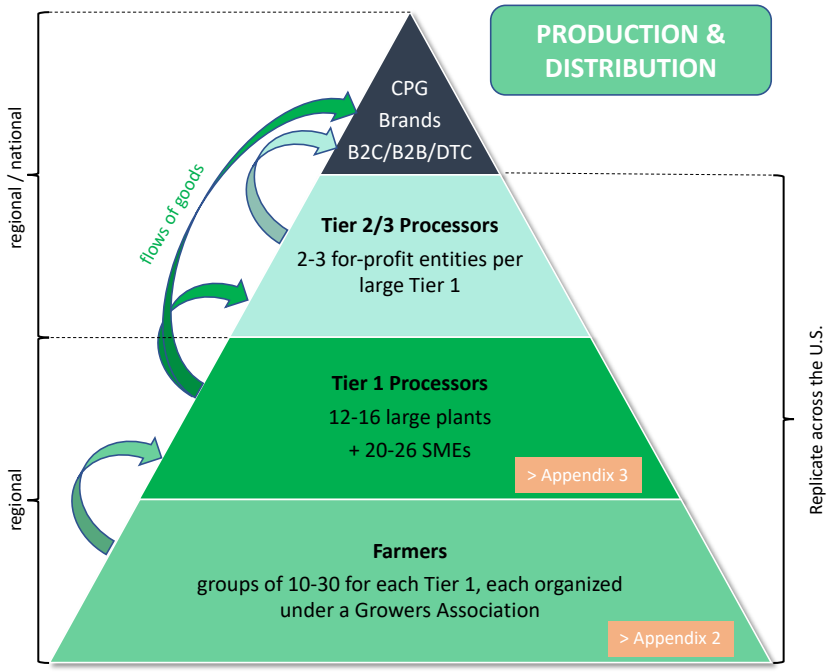
Here, we look more in detail at the first pillar, **Production and Distribution**. The pyramid structure shown below (specifically the three bottom layers) represents the structure of the industry in a specific state or region of the U.S. This structure is meant to be replicated across the country to scale up production nationwide.

The Tier 1 processors are about establishing the cornerstone of the industry at the local level, in rural areas near farmers. Tier 1 processors handle the primary processing; they provide farmers with the seeds and purchase the harvest. They process the stalk and grains into coproducts and basic finished goods.

- Establish 12–16 large and well-capitalized Tier 1 processors across different U.S. regions. The focus will be on building a strong bond with local farmers (within a 150-mile radius), a diversified go-to-market approach (B2C, B2B, and DTC) to sustain cash flow and maximize plant utilization, sound logistics, and connections with

nearby industries that will be buyers for the products. The first strategic objectives should be optimizing processes and establishing markets through products with low upfront costs.

- Encourage 20–26 small & medium Tier 1 operations that can reach profitability faster through smaller capex investments. This will be conditional on the successful maturation of smaller-scale processing solutions[f]. We see small & medium Tier 1 companies as an opportunity to foster farmer adoption and help the industry reach scale; those companies could later merge or be absorbed.
- From the experience of other industries, we consider it important to eventually federate farmers into local or regional growers' associations to build up political power and enable better integration and organization with processors. Farmers value the agronomics expertise that Tier 1 staff can bring to such a novelty crop like industrial hemp. As product development rises in complexity (for example, producing fibers for textiles), ensuring a joint effort on agronomics between the farmers as suppliers and Tier 1 as buyers will be paramount to produce to meet product specifications.



- Since 49% of U.S. farmers are willing to try new yield-increasing products to increase profits[55], industrial hemp should be attractive for three reasons: first, as a diversification tool; second, as a plant enriching the soil and improving yields on subsequent crops; and third, as a natural regenerative agriculture practice (hemp is a good rotation crop breaking up disease and weed cycles for other commodities and has also shown significant potential for reduced use of pesticides, herbicides, and irrigation requirements). Large farms (i.e., with acreage over 5,000) have been leading in implementing sustainable practices more than smaller farms; over half of large farms use regenerative practices like no till, low till, cover crops, variable-rate and controlled-release fertilizer. Therefore, large farmers, because they also have more land for trials and financial resources, could be early adopters of industrial hemp.
- *Appendix 3* contains a draft of the regional approach for Tier 1 processors.

Tier 2 processors will be essential to adding value, scope, and resilience to the value chain. Tier 2 processors use hemp's coproducts; they can blend hemp into their product formulations to manufacture intermediate goods or finished products. Basic products are a good place to start (chocolate bars, salad dressing, food-grade straws, insulation, etc.) to develop niche markets and reach profitability rapidly with reasonable investments.

[f] Like those offered by FormationAg in the U.S., eHempHouse in the UK, HempAct in France, or HurdMaster in Poland.

- First, promote hemp to existing companies that can easily include hemp in their materials or ingredient formulations and thus become Tier 2. This is a lower-risk approach and potentially a faster way to scale demand for Tier 1 products, thus sustaining the industry.
- Second, support greenfield hemp Tier 2 companies that need to prove their business model. These might be independent entities, joint ventures, etc.

Tier 3 processors will be focusing on more advanced products that require the integration of Tier 2 intermediate goods and will likely be highly specialized niche companies. As such, the supply they will require will have to be standardized, consistent, and in high volumes. Applications will be centered around industrial and consumer textiles, bioplastics, automotive components, and cellulose. At this processing level, the volume-cost equation will be most important to ensure the development of successful markets.

Examples of biomaterial construction with flax fiber.

French catamaran manufacturer Outremer built the We Explore for the Route du Rhum 2022, an Outremer 5X made of flax fiber, a sustainable alternative to fiberglass.

Swiss company Bcomp designs natural fiber composites for high-performance applications and sustainable "lightweighting". Porsche Motorsport launched the 718 Cayman GT4 CS MR featuring a full natural fiber bodywork kit, during the 2020 GT Nürburgring 24-hour race in Germany.

In 2022, BMW acquired a stake in Bcomp through its venture arm, BMW i Ventures. The BMW Group aims to increase the use of renewable raw materials and natural fibers such as hemp, kenaf, or flax to minimize base material usage while also achieving a weight reduction of up to 50% over conventional materials.

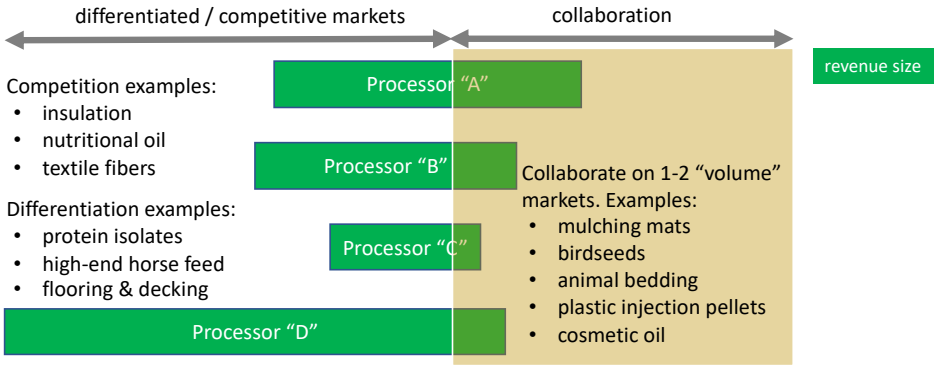
Hemp can be developed to meet the same applications at scale.

6.3 Scaling volumes and opening markets through collaboration

The nascent state of industrial hemp means that each individual processor's low production capacity is unable to meet industrial-size volumes that the market demands. Moreover, a lack of standards hinders buyers from purchasing from different providers and expecting that identical product specifications will be met. To resolve this, we see inter-processor collaboration as an achievable option.

- Each processor remains independent and pursues its own go-to-market strategy while choosing to collaborate with other processors on 1-2 specific markets where volume needs are large and product specifications can technically be met by all.
- Branding and standards can be developed together or intermediated through the Industrial Hemp Sustainability Alliance.

In the chart on next page, a "processor" is defined as either a Tier 1, 2, or 3. We expect that large markets will first be served by Tier 1 processors, but it is conceivable that some Tier 2 or Tier 3 processors may choose to join forces as well.



Another way to look at it: processors should collaborate on high-volume, low-value markets, thus leveraging branding, marketing, packaging, etc., with a view to control a particular segment of the market. Processors would compete or remain independent on high-value products. This is particularly relevant for industrial hemp since the plant produces grain, fiber and hurd, all of which should be utilized and commercialized for profitability reasons. Nevertheless, not every single processor can spend time and resources developing a product and a commercial strategy for each coproduct. Hence the opportunity for a processor to use the brand and the distribution channel already established by another.

Triggering collaboration between processors would be a good way to generate trust, open discussions on standards, and pave the way to establishing the Industrial Hemp Sustainability Alliance. Industrial hemp could become not simply a value chain but a *value web*, meaning a network with heightened capacity and resilience.

Standards will be extremely important to develop early on as buyers will preferably, if not always, want to have a replacement supplier in case the first supplier fails or is out of inventory (e.g., COVID was a big lesson). The replacement products must adhere to the supplier's requirements, and standards can ensure they do.

Note that within each product or market segment will offer a variety of approaches.

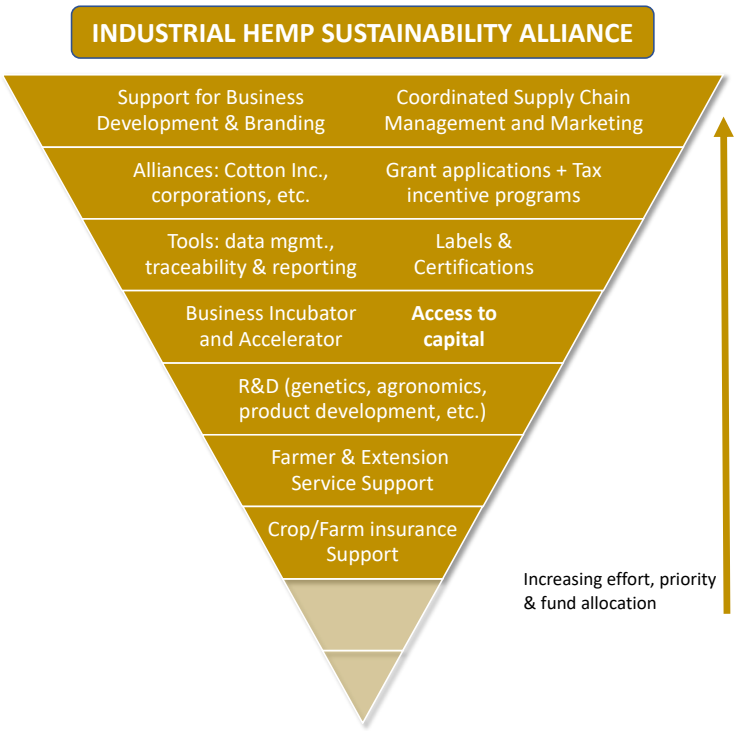
- In apparel fibers for example, hemp processors can pursue denim manufacturing, which is a low-hanging fruit: it requires volumes but is technically easier, and U.S. brands have local demand for "U.S.-sourced" cotton-hemp blend jeans. This is a high-volume approach that requires significant industrial investment and is a standard farmer-Tier 1 model as described in *Section 6.2* above.
- Another approach is a supply chain ecosystem (a more formal arrangement than the collaboration model described above), where the orchestrator of the ecosystem outsources part of the value chain. In the case of apparel fibers, a company could focus on the hemp-specific processing phase (the "degumming") while leveraging the existing numerous U.S. cotton gins to process the other phases of the hemp fiber. This distributed model of production would create more value for incumbents while helping a new industry to scale.

Le Slip Français (i.e., "The French Boxer") is a French B-Corp that uses an ecosystem model to source and manufacture sustainable textiles exclusively in France. The ecosystem encompasses growers (linen, cotton, hemp), breeders (wool), suppliers of materials and accessories (lyocell, recycled wool and plastics), spinning mills and distributors. Manufacturing is outsourced to 29 independently owned workshops, reviving the French textile industry, and sustaining 300 jobs.

6.4 Federating the industry through a national Sustainability Alliance

A Sustainability Alliance will be paramount to allowing the nascent hemp industry to "hit above its weight" earlier and to navigate the various phases of growth while mitigating some of the risks that will inevitably appear. We see three stages in establishing the Alliance.

1. 4-5 processors join forces and start collaborating on market development, standards or building key infrastructure. They establish the basic framework and legal entity, likely a non-profit.



2. Obtain funding: pursue government grants and philanthropic donations with the purpose of anchoring a new biomaterials and nutrition industry. Four initial axes for the Alliance:
   - Business Development and Branding: promote industrial hemp materials to existing manufacturers and facilitate partial adoption of industrial hemp in their product formulations. Support branding efforts.
   - Supply Chain Management & Marketing: coordinate processors in supplying specific markets at scale (as described in *Section 6.3* above) while strengthening the business capabilities of hemp processors.
   - Explore and support funding options on behalf of industrial hemp actors, especially grants, subsidies, and tax incentives. Coordinate with the various policy-oriented associations.

3. Expand the Alliance with formal memberships. Farmers, genetics firms, all types of processors, and any organization involved in the industrial hemp value chain should find benefits in joining the Sustainability Alliance.

From then on, the Alliance can develop the scope of its programs, either as part of the non-profit or through for-profit subsidiaries:

- Launch a formal education program or business incubator to nurture startups, facilitate adoption of hemp by existing companies and industries, and strengthen the individual capabilities of industrial hemp companies from during the early and growth stages.
- Create its own brands or certification programs.
- Explore alliances with other industries (cotton, forestry), with corporations looking for strategic initiatives, and collaboration opportunities with industrial hemp abroad (France, Canada, etc.). See table on next page.
- Support farmers in genetics, agronomics, and machinery.
- Recommend and support the implementation of tools and processes for ESG/MRP and traceability data.
- Develop a financing vehicle or fund to accelerate the industry.

The legal set-up of the Industrial Hemp Sustainability Alliance would benefit from a non-profit status, as it will need grants to start up and grow. It could possibly start as a 501 (c)(3) non-profit and later evolve into a 501(c)(6) trade association or a board of trade.

Once the industry is mature, obtaining that industrial hemp becomes a new research and promotion (R&P) program under USDA's Agricultural Marketing Service, like the United Soybean Board or Cotton Board, would allow more integration and the collection of industry assessments.

What about representation and lobbying? Working with policymakers, helping to shape laws and regulations, and directing government funding are paramount. The National Hemp Association, the U.S. Hemp Building Association, the National Industrial Hemp Council, and the Hemp Feed Coalition are four associations that have been at the forefront of advocacy, lobbying, technical discussions, and policy setting.

At some point, these various organizations may specialize or merge. We see two possible organizational models as the industry develops:

1. Two complimentary bodies: one industry-wide association centralizing all legislative and regulatory policy issues collaborating with the more operationally oriented Industrial Hemp Sustainability Alliance, focused on ensuring supply and on generating demand. This is the model used by the soybean industry.
2. One body with different departments or expertise groups, encompassing all the industry's needs, from supply and demand to representation, lobbying, and standards.

We do not foresee a checkoff program by 2030; this will require the industry to reach maturity. As a result, the various associations and the Alliance will need to be funded through grants and membership fees.

Alliances with…	Other Countries	Other Industries	Corporations
Why	• Processors from different countries are in a non-competitive situation. • There is limited economic value for farmers and processors in exporting; moreover, it goes against hemp's ESG value proposition. • Opportunity to supply multinational corporations across geographies.	• complementarity. EX: textiles blending cotton with hemp. • risk mitigation for ESG goals (de-carbonize, circularity, etc.). EX: cement manufacturers. • risk mitigation for supply chain risks. EX: droughts affecting cotton farmers.	*see Section 2.5*
What	• Licenses • Joint-ventures • R&D cost sharing • Product development • Staff exchanges for know-how transfers, career advancement/reward and staff retention	• Industry-level marketing & branding • Joint-ventures • R&D cost sharing • Product development	
Who	• Processors, especially in Europe	• cotton (Cotton Inc.) • forestry (Sustainable Forestry Initiative)	*see Appendix 5*

6.5 Developing Strategic Relationships with Corporations

As we noted in *Section 1.1* above, corporations, their boards, and shareholders are realizing that sustainability now drives business resilience and competitiveness. The value proposition of industrial hemp for corporations is to:

- secure or diversify the supply chain.
- meet the growing demand for sustainable products.
- augment existing products for competitiveness.
- meet committed or regulatory ESG goals.
- decarbonize the supply chain.

The approach, either at the processor level or at the Alliance level, would be to target companies in sectors particularly vulnerable to ESG or supply chain risks (some of which were identified in *Section 1.2* above). It is then a matter of assessing the compatibility of industrial hemp with their supply chain and the technical readiness of blending hemp.

Several departments within corporations can be targeted: R&D, Marketing, CSR & Sustainability, and Supply Chain. As industrial hemp brings both product augmentation and sustainability, it is a matter of finding out what the target corporation's priorities or challenges are. *Appendix 5* lists several examples of initiatives and needs.
We see several benefits in working with corporations:

- It might accelerate the implementation of traceability tools throughout the value chain (and secure funding too).
- It allows industrial hemp to evolve from a de-risking tool (ESG constraint or supply chain diversification) into full strategic initiatives that will open new markets and provide added competitiveness to corporate partners (investments, branding, R&D, etc.).

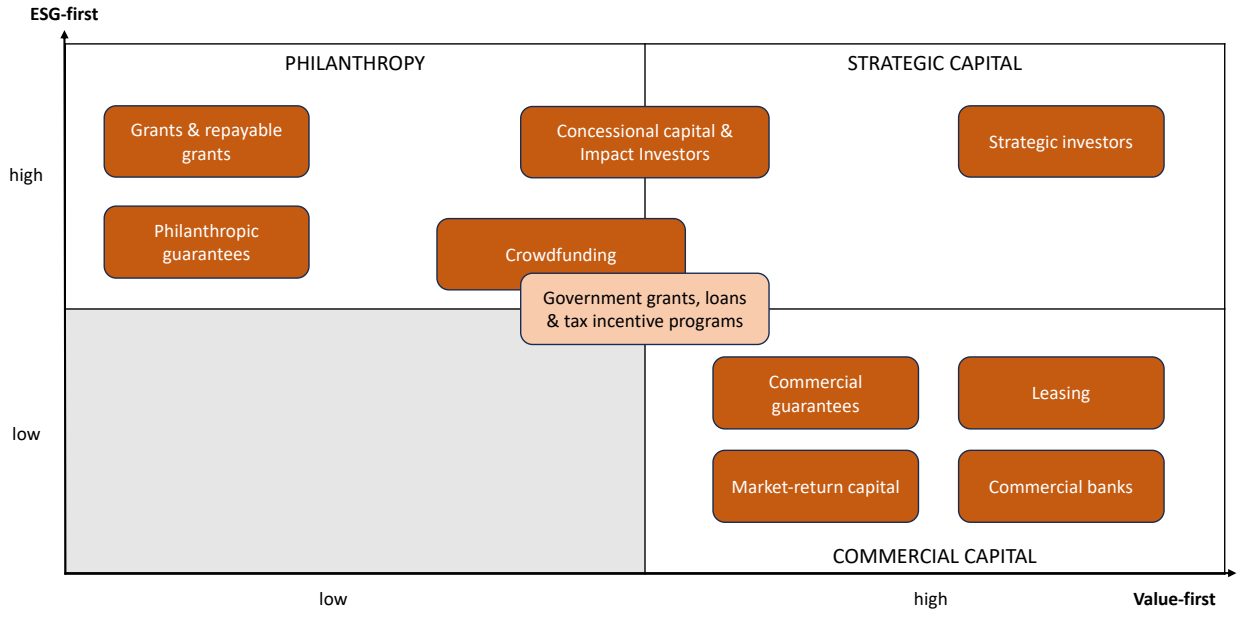
The hemp sector must, however, remain careful about whom it embarks on potential partnerships with. Large corporations are slow to decide and approve, which may not fit the imperatives of the hemp processors, who need to establish markets and generate cash flow as quickly as possible. Smaller types of corporations that are agile could be better partners to start collaborating with.

6.6 Securing Funding Sources

Last, securing funding will obviously be key to the success of the industry. We identify three main types: philanthropy, strategic capital, and commercial capital. For launching and growing a new industry, a blended capital approach of all three types is necessary to balance the risk-return equation and leverage the positive environmental and social impact that is one core element of hemp's value proposition.

The Industrial Hemp value proposition is wide enough to appeal to investors with various goals. We differentiate between ESG-first and Value-first.

- ESG-first investors will be more interested in the environmental benefits of industrial hemp and may be willing to sacrifice capital or returns to realize hemp's value proposition.
- Value-first will be attracted by the business opportunity but will likely be unwilling to sacrifice returns.



Philanthropy will be catalytic in de-risking private capital and thereby multiplying the environmental and social impact that private capital will generate. In the early years, we forecast that every dollar of philanthropic capital could incentivize up to four dollars of private capital in the form of debt or equity. Philanthropy can also fund activities and

projects to set up the general infrastructure for the entire U.S. industry (e.g., the Sustainability Alliance, traceability tools, grants to universities for research on agronomics and genetics, etc.).

In between philanthropy and commercial capital are impact-first investors and various types of concessional capital providers. These investors have specific ESG or impact metrics through which they select and allocate their funds; although return on investment is part of their mandate, that criteria can greatly vary in strength, from near-commercial to near-philanthropy. Crowdfunding platforms fall into this category and can also be powerful instruments for start-ups, mission-oriented organizations, or specific social groups (for example, farmers) to raise money.

Strategic investments will come from Corporations, PE funds, or family offices invested in one sector that industrial hemp targets. This will obviously be highly valuable, as it may combine funding (typically long-term) with a buyer for industrial hemp processors' output.
Commercial capital puts more emphasis on return than on ESG goals. Most of the capital for funding the industry will come from commercial players and will be critical to ensuring its growth, mainly funding capital expenditures and working capital for farmers and processors.

Securing government funding and tax incentives will be important to kick-start the industry. There is significant federal funding for infrastructure, renewable energy, and climate-smart agriculture, as well as tax incentive programs at the state level.

- "Inflation Reduction Act" (primarily a climate bill): major R&D in hemp for carbon sequestration and as feedstock for biofuels.
- Infrastructure Bill: potential funding for hemp fiber construction materials (erosion mats, noise barriers, engineered composites, building materials).
- The USDA Partnership for Climate-Smart Commodities invests over $50 million in hemp fiber and grain production.
- Intermediaries like Rural Business Investment Companies (RBIC) could also play a catalytic role through their equity investments.
- Rural business development grants, specialty crop grants but also loan guarantees, are various instruments to use.

However, government financing remains limited, and private capital will be the largest source to fund the development of the industry.

7. Measuring ESG and Ensuring Traceability

Industrial hemp meets 10 out of the 17 United Nations' Sustainable Development Goals. It constitutes an excellent portfolio rotation for farmers that benefits the soil and improves yield on future crops, retains water, and reduces chemical use while offering a more stable price than commodity crops; all these elements should benefit farmers' income. It also creates jobs in rural areas as Tier 1 processors need to be close to farming operations; even more, it has the potential to generate industrial hubs as Tier 2 and Tier 3 processors may choose to be nearby their Tier 1 supply.

Hemp's seeds are extremely nutritious and can contribute to food security across many geographies. Biomaterials made with industrial hemp could contribute to reducing the pollution of water and land, while its carbon capture and sequestration properties make it an ideal tool for climate action, especially for corporations.
Given that sustainability is at the core of industrial hemp's value proposition, measuring it and ensuring traceability throughout the supply chain will be key.

- **Industrial hemp processors** need the data to promote their sustainability rationale, especially if they pursue labels and certifications.
- **Investors and Corporations** need to measure the sustainability improvements coming from their involvement in and use of industrial hemp.
- **Consumers** demand verification of the traceability and sustainability of the products they purchase.

The Industrial Hemp Sustainability Alliance will encourage and finance Life Cycle Assessments on the various products. Additional work will likely be initiated to ensure that industrial hemp becomes part of relevant labels and certifications (beyond the regulatory ones) that focus on social and environmental impact.

The GIIN's Iris+ Agriculture Framework[56] will be used to measure sustainability and impact. Some of the metrics proposed are:

- Increasing the financial health and profitability of farmers;
- Farmers accessing agriculture products, services, and trainings;
- Sustainably managed land;
- Greenhouse gas emissions mitigated or carbon sequestered;
- Agricultural SMEs financed responsibly;
- Investee revenue growth;
- Decent jobs supported at or above a living wage;
- Jobs created in rural areas and in tribal lands;
- Improving climate resilience through agriculture;
- Improving ecosystem health and water use practices.

Traceability will be implemented within each industrial hemp processor's ERP/MRP SYSTEM. This initiative will be supported by the Industrial Hemp Sustainability Alliance (*see Section 6.4*) and possibly in collaboration with Corporations.

Corporations that are part of the Science Based Targets Initiative (SBTi)[g] will find industrial hemp a natural ally in their greenhouse gas emissions reduction targets.

A full theory of change and impact thesis is to be developed (see *Section 10*).

8. Products and Markets

It is important to establish industrial hemp in the marketplace early on. To do so, a dual approach of volume markets combined with niche markets should be pursued. Volume markets will necessarily be "lower tech", meaning the technical capacity should already be available to produce at scale while maintaining consistency and quality at a bare minimum; for these, we can expect a longer ramp-up to reach profitability, hence the need for well-capitalized Tier 1 processors. Niche markets, on the other hand, can generate returns faster as they do not necessarily need to be highly technical; however, they are only a small step in creating an entire industry.

In this section, we try to explore what products and markets constitute the best roadmap for the industry and how to capture and retain their value.

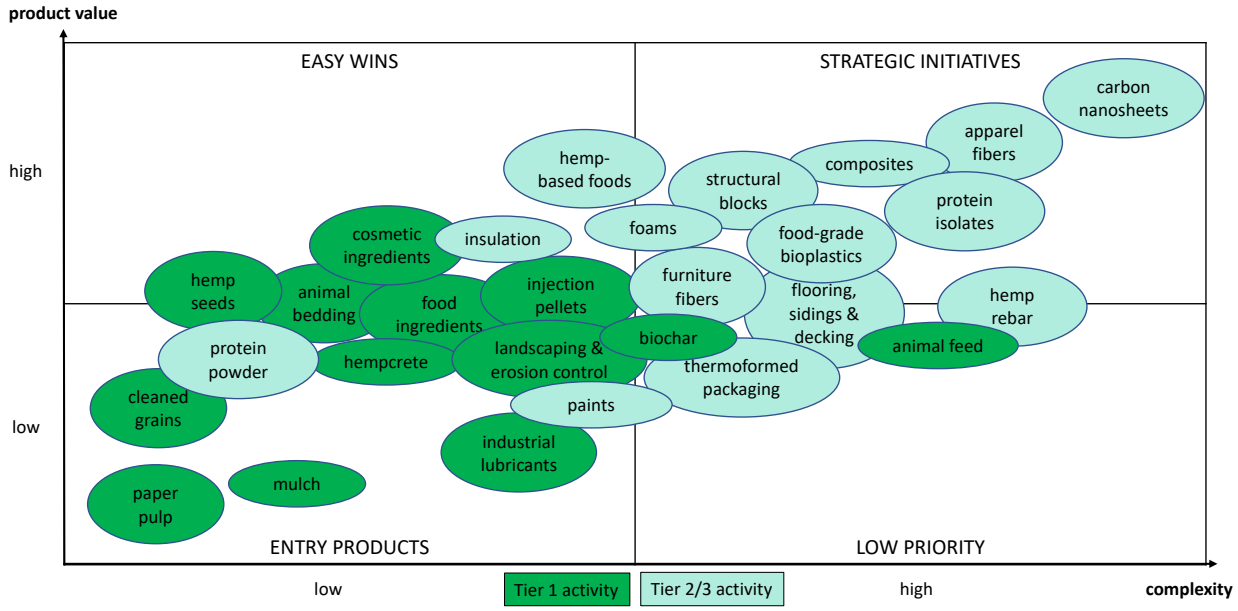
[g] SBTi: https://sciencebasedtargets.org/how-it-works

8.1 Value-Complexity Matrix for Industrial Hemp Products

The matrix below categorizes some of the multiple applications of industrial hemp in order to prioritize market development. Obviously, this nascent industry should concentrate on the "entry products" and "easy wins" categories.

By "product value", we understand here the monetary value to a processor, whether a Tier 1, Tier 2, or Tier 3. One dimension not included here are geographical specificities: one region or state might be better at producing fibers for textiles than another, given their climate, soil, or even the industrial know-how around them.

The "complexity" measure encompasses capital expenditures, technology maturity, technical expertise, and regulations. It is important to remember that no research on industrial hemp had been done in the U.S. for 80 years. As the industry restarts, everything needs to be learned, invented, or approved.



Several questions come to mind when considering the matrix:

- Since the current U.S. production capacity is small, what are the markets that should be given priority?
- Should a diversified production model be pursued to spread risk, or should a limited number of large markets be targeted?
- When will the supply chain be stable and consistent?

Answering these questions will require a concerted effort by the pioneers of the industry, leveraging the learnings from other countries and industries. One core objective of the Sustainability Alliance is to facilitate those discussions and advance optimal methodologies to develop the industry.

8.2 Capturing and Controlling the Value of Industrial Hemp

The strategic consequence of the confusion surrounding hemp (i.e., industrial hemp vs. CBD and cannabis) impacts the choice of markets to develop. While the U.S. legislative mood on industrial hemp generally appears favorable, there is still uncertainty regarding the actual passing of legislation at the Federal level that would distinguish industrial hemp from CBD and cannabis. From a risk standpoint, the decision tree starts there, as businesses will have to consider this uncertainty and the perception it may generate at the investor, business partner, and consumer levels.

B2B, B2C, or DTC marketing need not push forward the word "hemp". Until the regulator establishes a distinction between industrial hemp and CBD/THC applications, the stigma attached to the plant may remain. Therefore:

- Focus messaging on benefits instead: high proteins, high magnesium, high dietary fibers, durability, lightweight, CO_2 sequestration, etc.
- Push farmer stories in B2C and DTC products (e.g., "this farmer grew your product").

To realize the value of industrial hemp, it is paramount to monetize the full scale of its value proposition.

- Environmental attributes: soil benefits, CO_2 sequestration, lower water usage, and a substitute for petroleum-based or synthetic materials.
- Performance attributes: lightweight, durable, mechanical stiffness, capacity to blend, nutritional content, etc.
- Scope: the breadth of applications for industrial hemp is large and growing.

Hemp products need to be priced competitively in the marketplace. Nonetheless, hemp processors should be careful not to follow a race to the bottom to gain market share, which would let buyers (i.e., large corporations) capture all the ESG value. Price negotiations should consider the buyers' need for decarbonization.
On the consumer front, although sustainability, today, is *expected* and does not necessarily warrant higher prices, consumers will be ready to pay a premium for the performance attributes brought by hemp (durability, etc.).

Moreover, hemp has further potential for upcycling, i.e., taking a waste material and increasing its value.

- The grains' hulls are highly nutritious, especially in terms of dietary fibers, but are currently discarded during the dehulling process to extract the seeds. Hulls represent about 50% of the grain's weight, so they have a significant potential value-add.
- The residual straw from grain processing could be developed for fiber applications.

We suggest also increasing demand by using labels, certifications, and traceability, which will increase visibility across all sales channels.

- 66% of consumers are ready to pay more for sustainable products (80% of young adults, ages 18–34). But 78% say they do not know how to identify sustainable firms; 75% use labels or certification to validate firm credentials[57].
- Regenerative Agriculture and other natural, sustainable, and health initiatives labels will make it easier for consumers to find the products.
- Organic foods ($57.5 billion in 2021, U.S.) have been growing at a sustained rate of over 18% a year. There is obviously a match between hemp's environmental and health attributes and the organic movement.
- A few examples of major labels are:

Next, promoting to Corporations will help the industry grow by leaps and bounds instead of gradually.

- Corporations need to achieve Scope 3 improvements: the European Union is regulating more and more, and the U.S. may soon follow. This is an opportunity to capture a value premium only for the environmental attributes of products made with industrial hemp.
- Establishing a formal alignment with the circular economy will help promote hemp to corporations and other industrial sustainability initiatives.
- Given the volume constraints, smaller markets are preferable. For example, a regional distributor should be preferred to a national one.

More details on Corporation involvement in *Appendix 5*.

To control the distribution of industrial hemp's value between farmers, processors, and resellers, it would be wise to adopt an approach like the Fair Trade movement early on, which codifies a set of principles across the value chain. Given the sustainability boon that industrial hemp offers, farmers and hemp processors have a strong case to retain a significant part of the value when negotiating with buyers and avoid having one part of the supply chain capture all the value. Moreover, hemp may not fit the typical trading on U.S. commodity exchanges given the specific applications that each sectoral use entails (textiles, construction, etc.); it is likely that each buyer will have purchase specifications that impact not only the Tier 1 processing but the agronomics and genetics at the farm level. Developing standards for the industry in partnership with bodies like ASDN, ISO, etc. will be paramount.

As a result, a hemp product manufacturer should aim to have its own brand, while doing white label and private label production. This will maximize raw material utilization (different grades / quality levels) thus profitability, and allow to ramp up volumes, while having better control on the distribution channels.

8.3 Potential Priority Markets

As mentioned in previous sections, corporations have a sustainability imperative, whether mandated by regulations, created by lawsuits, or because of growing risk in their supply chains. The choice of markets to pursue should also take that dimension into account.

The table below shows how urgently some specific industries need to decarbonize their supply chains and products. The higher the urgency, the better the opportunity for hemp.

	ESG Vulnerability / Sustainability imperative		
	urgency of opportunity for industrial hemp →		
Sector	low	medium	high
Plastics & Composites	• Foams	• Automotive (dashboard, panels, etc.) • Other industrial plastics & composites (leisure goods, etc.)	• Consumer and single-use plastics • Packaging (replace petroleum plastics)
Textiles & Furnishings		• Furniture (textiles) and bedding	• non-woven (feminine care, wipes, etc.) • Apparel
Pulps & Paper			• Packaging (substitute wood pulp)
Construction	• Landscaping and erosion control • Decking and flooring • Paints • Rebars (coastal environments)	• VOC-sensitive environments: vineyard cellars, health facilities, etc. • Wood products from non-professionally managed forests	• Government buildings (renovation and new construction) • Insulation (substitute fiberglass) • Hempcrete and structural blocks (substitute concrete)
Nutrition: Food	• Cosmetics • Prebiotics and probiotics	• Protein isolates • Meat analogues (substitute soy protein)	• Food ingredients (especially organic, gluten-free and regenerative agriculture segments)
Nutrition: Feed	• Horses, birds, fish • Pets		

9. Capital Approaches and Investor Profiles

We estimate the total amount needed to anchor the industry at $1,642 million (inflation-adjusted) for the period 2024–2030. The amount covers working capital, capital expenses, some funds for research and development, business development and marketing, and tools to integrate the supply chain. As with any nascent industry, strong capitalization and access to funding will be critical to mitigating the inevitable growing pains.

Philanthropic capital will be paramount early on to start up the value chain and can take various forms (grants, matching grants, repayable grants, guarantees, etc.). Donors can have a general approach to hemp's value proposition or have specific goals (for example, a focus on nutrition or soil degradation); moreover, they will help shape some of

the ESG goals and metrics used as the industry develops, raise awareness, and promote industrial hemp's progress and achievements.

Government tax incentives, subsidies, and grants will act as a strong signal to the private sector that industrial hemp has the approval of the Federal government and State legislatures. We expect that job creation and the revitalization of rural areas, in addition to tax revenues, will figure strongly in their decision-making. Securing a guarantee from USDA, for example, could have a huge multiplier effect on securing private capital.

Average Funding (m$)	TOTAL
Genetics firms	$46m
Farmers	$80m
Processor: Tier 1 - Large	$587m
Processor: Tier 1 - SME	$109m
Processor: Tier 2 - Large	$124m
Processor: Tier 2 - SME	$75m
Processor: Tier 3	$490m
Sustainability Alliance	$36m
Other*	$96m
TOTAL	**$1,642m**

** Machinery development, logistics and R&D*

Private capital, both impact and commercial, will provide the bulk of the funding in the form of debt, equity, leasing, and other instruments (see *Appendix 4*).

This paper does not explore revenue from carbon credits (i.e., carbon offsets or Carbon Dioxide Removal certificates), although we recognize the potential to favorably alter the economics of the industry in general and for certain products in particular. For example, a processor manufacturing a hemp product that is not price-competitive due to low volumes could sell carbon credits and subsidize a lower price until it generates sufficient economies of scale. This, of course, requires an initial investment; the Industrial Hemp Sustainability Alliance could define an industry-wide program to support such initiatives.

9.1 Goals for the Industry by 2030

While it is difficult to predict how a new industry is going to evolve, we can certainly frame a roadmap to success.

	Today	by 2026	by 2030
Genetics	• limited genetics restrict geographical zones and lower yields • only one U.S. genetics company	• specific genetics for South-West and Midwest • hybridized seeds for improved yields • 2-3 U.S. genetics companies	• genetics offering adapted to most U.S. zones • 30-50% price decrease on seeds thanks to higher volumes
Farming & Agronomics	• limited farming experience • limited acreage restricts raw material supply	• first U.S. studies on improved yields on subsequent from hemp rotations • over 10 farmers associations created • acreage increased to 42k acres • agronomics tools and trainings widely available	• acreage increased to 150k acres • field pre-processing machinery will increase consistency & quality and bring more value to farmers • agronomics reach a sufficient maturity to improve raw material consistency and harvest output
Processing	• less than 20 processors, most of them start-ups • technology & processes are still being developed • no standards, limited product product consistency; raw material imports	• 8-10 large Tier 1 processors + 16 SMEs • 13 Tier 2 processors • 7 Tier 3 processors • processes have been refined, generating common practices and higher consistency • EBITDA profitability achieved for half of processors	• 37 Tier 1 processors • 17 Tier processors • 15 Tier 3 processors • net profitability achieved for half of processors • raw material imports lower than domestic raw material production • technology and know-how mature enough to enter growth phase
Markets	• niche markets, no depth, no scale	• The Industrial Hemp Sustainability Alliance has initiated the groundwork for 1-2 markets at scale, several alliances with Corporations and set up a captive farmer insurance program • Application development opens 1-2 ingredient food markets • Several brands in nutrition and construction gain consumer recognition	• Alliance with Cotton Inc. formalized to promote U.S.-sourced hemp / cotton blends • U.S. labels for industrial hemp developed • Automotive market launched
Funding & Investors	• private capital only, with limited government funding	• $69M of government funding • $12M of philanthropic capital • over $500M of private capital committed	• $237M of government funding • $32M of philanthropic capital • $1,372M of private capital committed
Laws & Regulations	• industrial hemp not differentiated from CBD & cannabis • no UDSA insurance for lack of history • no Federal ruling on feed	• Farm Bill 2023 has established industrial hemp with specific regulations and name • Federal ruling has allowed hemp to enter the feed market at scale	• USDA insurance available

9.2 Risks for Investors

We provide here a high-level outlook on the risks attached to this nascent industry.

Teams: some firms exhibit founders with little practical experience, whether business, technical, or industrial. Some founders exude more passion than experience and are developing their skills as they go. The professionalization of the sector is happening rapidly as skilled talent gets involved. Additionally, hiring skilled labor in rural areas and small towns is a challenge. Risk: medium.

Scale: the roadmap to scalability is still a work in progress. Supply is being developed in parallel with products, know-how, capacity, and markets. This is a delicate juggling act for this nascent industry. Risk: medium-high.

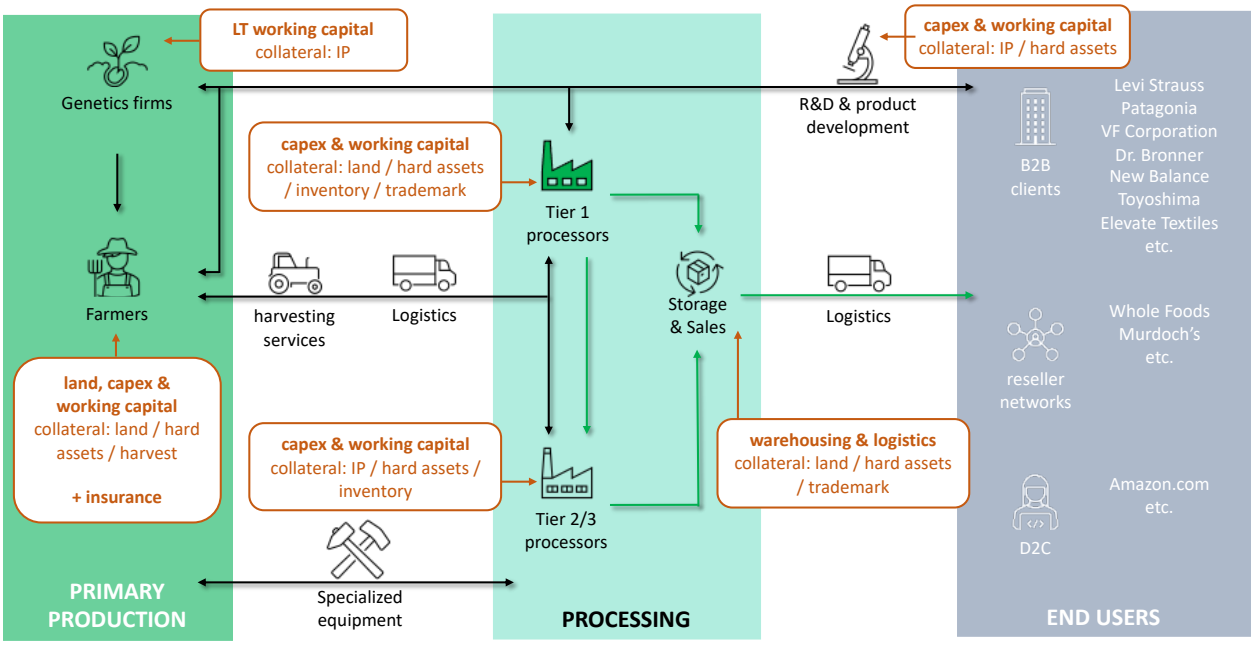
Moat: as an agriculture-based industry, the know-how to obtain the right raw material and process it is a real challenge. Tier 1 processors can trademark their B2C products; patents will likely develop only at the Tier 2 and 3 levels. Genetics companies are good targets for investments targeting IP. Could the ABCD multinationals (ADM, Bunge, Cargill, and Louis Dreyfus) seize the market? Without presuming what their strategic goals are, given the small volume that industrial hemp represents, the four global giants are likely to wait on the sidelines for the industry to develop before stepping in (more in *Appendix 8*). Risk: low.

Regulations: there is a risk that the current political situation will hinder the ability of the U.S. Government to ease the regulation of hemp. Regulations affect farmers, marketing, and insurance. Although the USDA issued $35 million in grants for hemp specifically in 2023, the new proposed regulation included in the Farm Bill 2023 will be critical to freeing the industry from various constraints. Risk: medium-high.

Follow-on funding: the current macro-economic outlook could become unfavorable for raising capital. With high rates, high uncertainty and low liquidity, funding in the short to medium term may be challenging to secure. Risk: high.

9.3 Investment Opportunities, Collateral Options, and Risk-Mitigating Factors

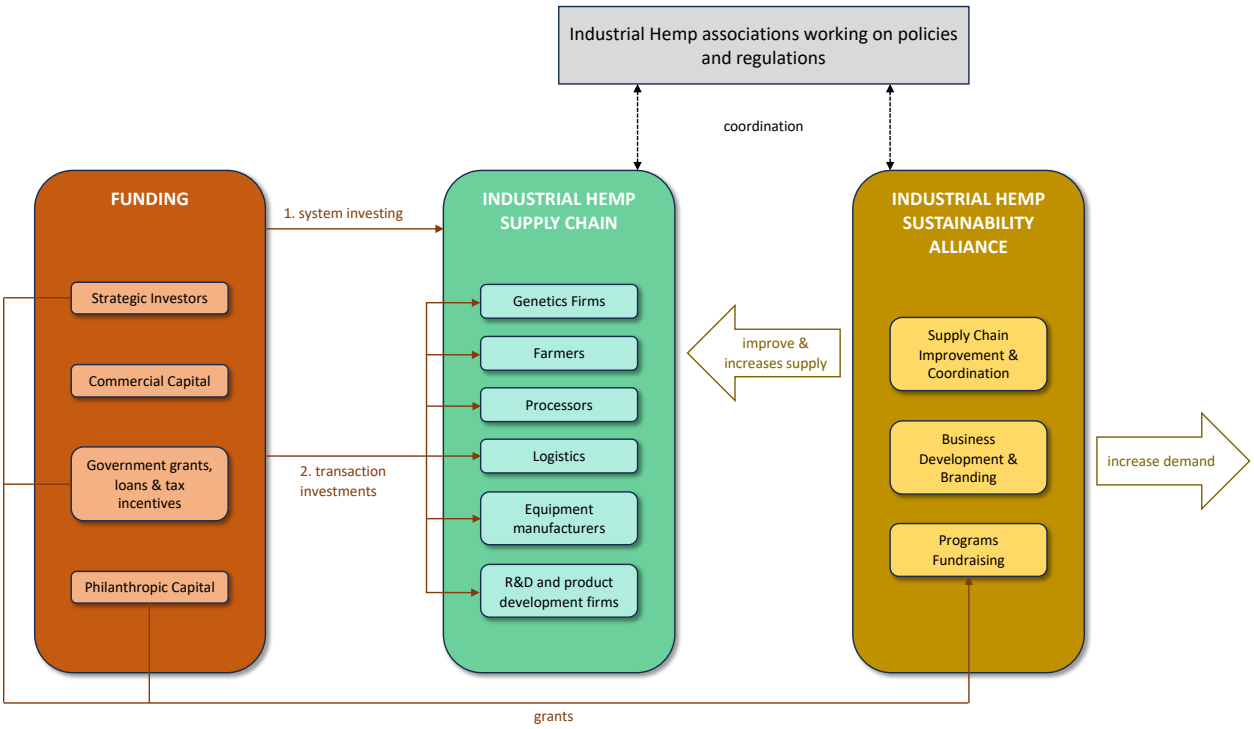
As mentioned above, there are multiple opportunities for investors and corporations to invest in the value chain through different instruments and collateral options. We show below a summarized view.



Two different approaches can be taken by investors and donors: system investing and transaction investing.

1. System investing aims to build an integrated supply chain, from farming to end product. This comprehensive approach aims to invest into various parts of the value chain to address the various gaps in supply and demand; it requires large amounts of patient capital, a team combining various skills, and a diverse array of partners (especially buyers). Projects in Canada and the U.S. are, for example, establishing industrial parks which act as hubs for processors, sometimes with buyers. This approach can be highly efficient in ensuring whole plant utilization, rapid coordination between processors and buyers and product standards, innovation, etc. We believe supply chain risk mitigation is also significant.

2. Transaction investing is less ambitious featuring one or a few targeted investments. The approach is opportunity driven. If performed in sufficient numbers by multiple investors across the country, it has the potential to strengthen the supply chain. However, they are probably riskier given the lack of built-in integration in the supply chain from the beginning.

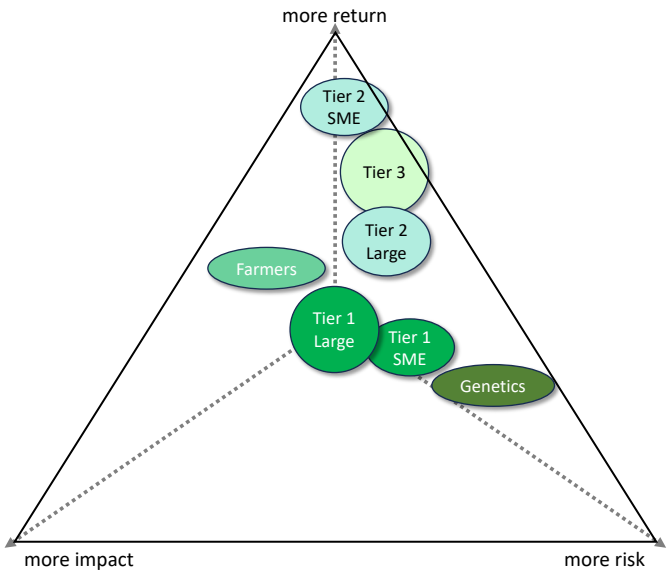


A few risk-mitigating factors to mention:

- The Sustainability Alliance will act to de-risk some areas of the value chain and to balance risks between different actors through better tools, information, training, access to capital and markets, and overall coordination.
- Investors can choose from a menu of investment targets in the industrial hemp value chain that offer different risk, return, and impact profiles, together with specific collateral options (see *Section 9.4* below).
- Government funding and philanthropy will help supplement and de-risk private capital by acting as first-loss layers. Accessing this type of funding can be centralized or supported by the Alliance.
- Risk-mitigating instruments: in the absence of a plethora of venture capitalists interested in non-tech agricultural solutions, venture debt and convertible debt are proven models for start-ups. Leasing is another; one financing structure would include the investor purchasing the equipment, taking the accelerated depreciation tax deduction, and bringing in cash flow by leasing to the investee.
- Innovative funding models for economic actors with triple bottom-line objectives (*see Appendix 4*).
- International funders are also an option; many ESG and impact funds in Europe could become investors.

9.4 Simplified Investment Profiles

The risk appetite of each investor can be matched to the different needs of the industrial hemp value chain. Below is a simplified representation of the risk-return-impact equation.



Large Tier 1 processors represent a significant dollar investment and will have a strong impact through the creation of rural jobs and the direct effects on farmers and farmland. Risks are present due to the complexity of agriculture-based operations, and returns will take longer to come but will eventually be growing. They are shown at the center of the triangle as, compared to the other investing options, they represent a balanced risk-return-impact equation.

The less risky option with the potential to bring a fast and/or positive return is Tier 2 investing: an existing company with an established revenue model and profitability that decides to add industrial hemp to its product formulation or to start a dedicated product line. Although the impact might be lower (due to a smaller size of business and more remoteness from the farm impact), it is an important way to channel sustainability to consumers or downstream businesses. The difference between SME and Large Tier 2 is a higher capital need for the latter and potentially more specialization, thus an overall higher degree of risk.

Tier 3 firms will probably offer significant return potential with less impact and more risk. They will need advanced technology, thus capital expenditures, R&D funds, and sufficient cash runway to develop their markets; these will likely be niche markets, and the firms will have to manage a complex supply chain.

Farmers should represent a low-risk investment opportunity (mainly machinery and storage buildings) as the goal is to acquire assets as a group (i.e., the growers' association) and since industrial hemp will represent only part of the crop portfolio (5–10% for large farmers). Our model also assumes subsidies for seeds until economies of scale and competition among genetics firms bring the cost down.

Genetics firms may bear a little more risk given the time from research to market, but the returns should be adequate.

As shown in *Section 9.3* above, there are other opportunities to invest in the value chain using different instruments: leasing of machinery for farmers or processors, project finance for large plants, warehousing, logistics, machinery manufacturers, etc.

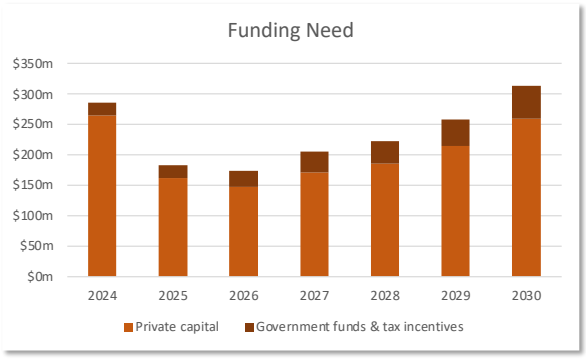
The current assumptions per investee are indicated in the table to the right (funding until cash flow break-even).

Average Funding (m$)	Capex	WC/Sales%
Genetics firms	$15.00m	
Farmers	$0.05m	
Processor: Tier 1 - Large	$30.00m	18%
Processor: Tier 1 - SME	$4.00m	15%
Processor: Tier 2 - Large	$20.00m	20%
Processor: Tier 2 - SME	$3.00m	15%
Processor: Tier 3	$25.00m	22%

9.5 Timing of Funding

Our current scenario considers the acceleration in the number of industrial hemp companies that are starting, which means the funding need is already high; the chart next page reflects that with a high figure in 2024. Whether that need will be met is a different question.

While we modeled a progressive ramp-up after 2024, development usually happens in clusters, so funding needs might be more erratic: higher or lower, faster or slower. The timing will obviously have an impact on the market size in 2030.



While different actors and initiatives will strive to meet the funding needs of the industry, the goal should be to ensure a healthy foundation that will enable steady growth with as few booms and busts as possible and in cooperation with the other pillars of the industry and the Industrial Hemp Sustainability Alliance in particular.

We believe it will be important to set up investment vehicles for the industry. One such vehicle, rePlant Hemp Impact Fund 1, LP, is leading led the charge with a first close targeted at $35 million.

Having several funds with a strong emphasis on industrial hemp will allow meeting the funding need, diversify risk through different investment strategies and co-investing, and generate opportunities for information exchange and even shared due diligence. Moreover, we believe that it will send a strong signal to farmers, entrepreneurs, and government bodies about the momentum in the industry.

10. Next Steps

As this report tries to convey, the U.S. industrial hemp is a nascent industry with immense long-term potential. Establishing the proper foundations that will set the industry up for success in the long run is a delicate act. Again, the goal is twofold:

1. Accelerate the development of industrial hemp as a full value chain from the historical 70+ year-benchmark (based on comparisons with other agro-industries) to a shorter 20-year timeframe.
2. Minimize the booms and busts by federating industry actors, ensuring that both capital and technical assistance are available early on, and establishing the proper systems and organizations to support the industry's development.

10.1 The U.S. Industrial Hemp Accelerator

bioSolutions Initiatives will be the general coordinator of this effort, and in collaboration with several actors in the industry, will initiate a set of 5 key initiatives for the next 12–18 months. These initiatives together constitute the **U.S. Industrial Hemp Accelerator**; other initiatives may be added to the Accelerator in the future.

bioSolutions Initiatives
LEADING THE WAY IN REGENERATIVE FINANCE

The five initiatives are described on next page. Please note that the year beside each initiative's title is its start, and although the initiatives are numbered, they are not necessarily sequential. For a Gantt chart view, please see *Appendix 11*.

1. RAISE AWARENESS AROUND THE U.S. INDUSTRIAL HEMP OPPORTUNITY – 2023

1. Promote this report to donors, investors, government agencies, corporations & their venture arms, and farmers
2. Refine investment thesis from the feedback received
3. Build a shortlist of potential donors, investors, and partnerships for the Industrial Hemp Sustainability Alliance (initiative #3) and for the Blended Capital Fund (initiative #4.2)

2. INSTITUTE ROUNDTABLE TO SPEARHEAD STRATEGIC INITIATIVES – 2023

1. Attracting capital
2. Policies, regulations, and industry branding / image
3. Federating & de-risking the industry; governance

Goal: define and prioritize initiatives under the U.S. Industrial Hemp Accelerator; some will be integrated in the Industrial Hemp Sustainability Alliance's programs (initiative #3).
Who: processors, associations, farmers, and financiers who are leaders in industrial hemp

3. ESTABLISH the INDUSTRIAL HEMP SUSTAINABILITY ALLIANCE – 2023

1. Tactical: 5-8 Tier 1 processors gather to address 2-3 operational issues (standards, etc.)
2. Organizational:
   - legal entity set-up + staffing
   - define goals & activities for 2024-2025 and budget
   - membership structure + fundraising for the Alliance
   - coordination with NHA, NIHC, USHBC, and other associations

4.1 INTERMEDIATE DIRECT INVESTMENTS – 2023

- evaluate companies
- pitch funders

4.3 ACTIVELY CO-INVEST with OTHER FUNDERS

- rePlant Hemp
- etc.

deal pipeline

funder pipeline

4.2 LAUNCH BLENDED CAPITAL FUND – 2024

- form Advisory Board
- define investment approach
- develop theory of change
- build pipeline of investable projects
- financial modeling
- risk mitigation / investment readiness
- define fund terms
- target capital sources

5. MARKETING CAMPAIGN – 2024

1. Assuming favorable outcome from Farm Bill 2023, communicate nationally about the approved changes regarding Industrial Hemp's status and regulations
2. Communicate about the Industrial Hemp Sustainability Alliance's initiatives
3. "One Plant" documentary film release - www.oneplant.film
4. Relaunch the Hemp Innovation Challenge at World Ag Expo
5. Consider industry trademark for North American-sourced, North American-made industrial hemp products

The details and budgets for each initiative are kept separately from this report and are available upon request. In the next section below, we describe bioSolutions Initiatives's priorities.

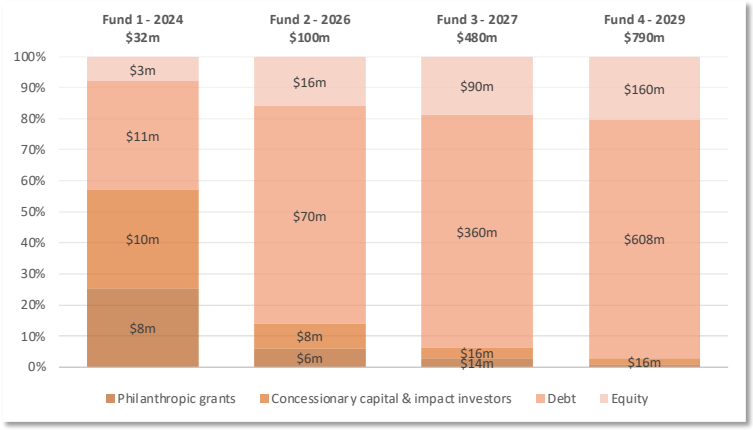
10.2 Launch Blended Capital Fund - 2024

As described in *Section 9.5* above, we believe it will be important to set up several investment vehicles for the industry that have different approaches and risk profiles, and that can generally cooperate or even co-invest.

Therefore, initiative #4.2 is about launching another vehicle in 2024 with a **blended capital approach**[h] and, within industrial hemp, a value chain or sectoral investment strategy. As we demonstrate the viability of the investment approach, the aim would be to create follow-on funds.

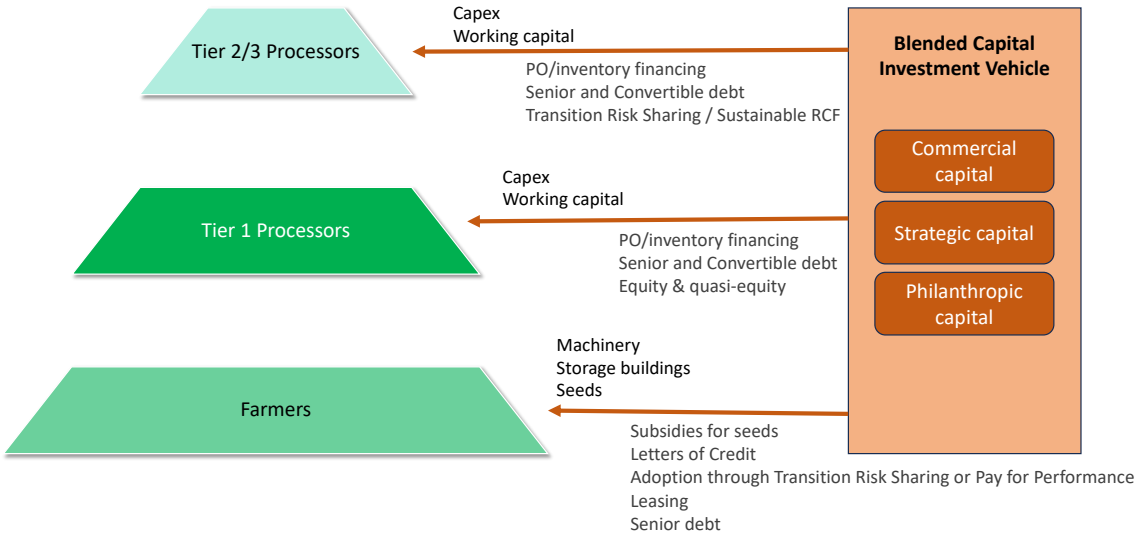
The chart on the right exhibits the aggregate amount needed to finance the industry by 2030 and represents a possible ***financial mix*** required to achieve that goal with a variety of funders and donors, either financing specific actors or participating through one or several funds.

Any variation on this example is possible; the main conclusion to draw is that **fundraising success will depend on gathering different actors**.



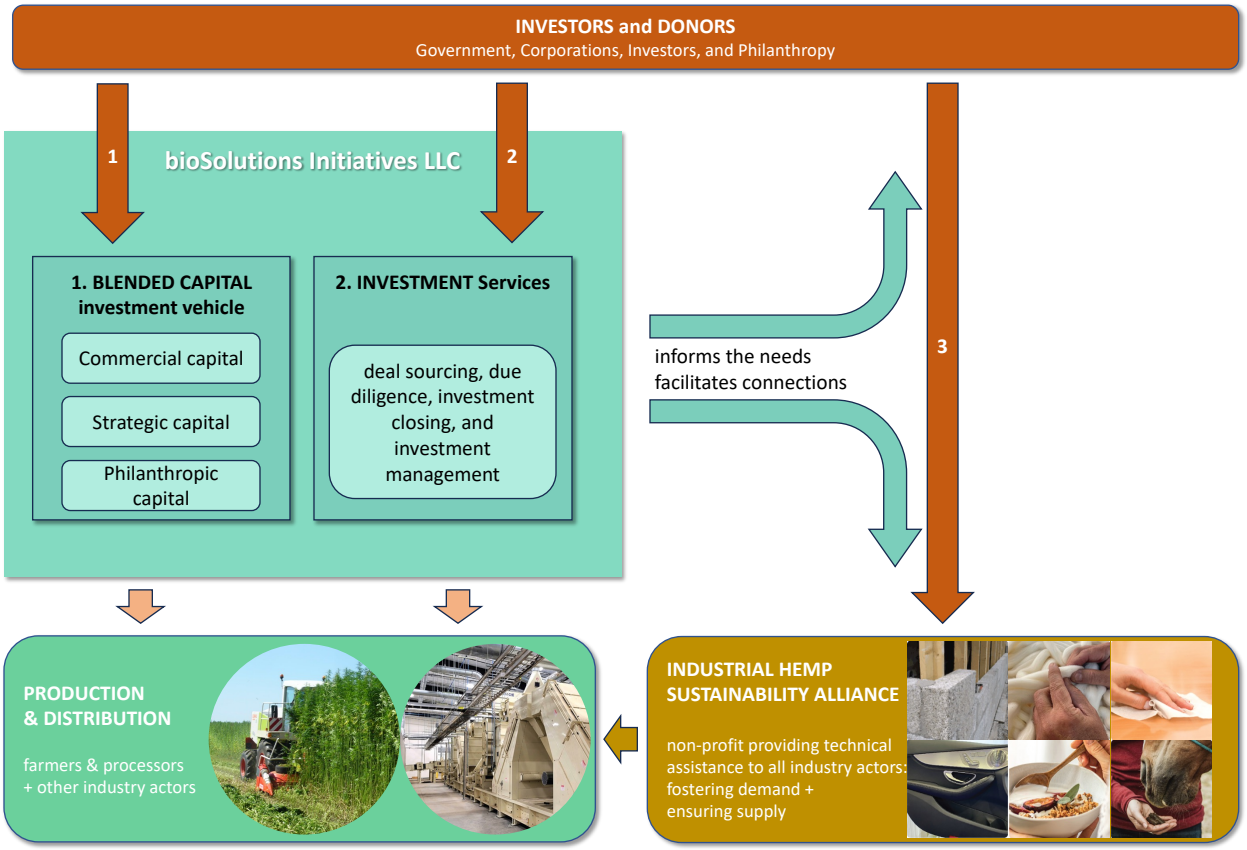
With such a nascent industry, **creating a track record of successful investments** and companies will be paramount. That is why we envision a first small fund with an equally short duration to ensure limited risk to start with. We plan to mostly invest using collateralized debt instruments, possibly with some convertible notes or venture debt. Depending on the mix of philanthropic capital, additional products might be added.

A high-level investment approach is represented below. There might be diversification opportunities to genetics firms, logistics companies, machinery developers, etc.



[h] Blended finance is the use of catalytic capital from public or philanthropic sources to increase private sector investment in sustainable development.

As bioSolutions Initiatives promotes the opportunity to a range of potential investors and donors interested in the industrial hemp value proposition, three ways to get involved are proposed.



1. **Launch of a Blended Capital Fund in 2024**: combining philanthropic grants, equity, debt, and possibly government funds into a vehicle to achieve an optimal return, risk, and impact outcome. We envision a $25–35 million first fund with a short duration to ensure limited risk and issuing mainly collateralized debt, possibly with some convertible notes and venture debt. Follow-on funds will be launched as the industry grows. bioSolutions Initiatives will ensure the operations of the fund.

2. **Investment Services**: investors and donors preferring a targeted approach by sector or specific themes can choose to directly invest, either by themselves, or as illustrated above, through bioSolutions Initiatives who will offer deal sourcing, due diligence, investment closing, and investment management.

3. **Industry-building technical assistance initiatives** will be managed by the Industrial Hemp Sustainability Alliance to ensure that best practices and constant enhancements are adopted and implemented. These include business and market development, supply chain improvements, alliances with other industries and sectors, labels & certifications, business incubation, product life-cycle assessments, etc. bioSolutions Initiatives will use the Alliance's programs to strengthen the investees it works with, will inform the Alliance of the needs of the industrial hemp actors, and will promote the Alliance to donors.

10.3 Potential Investors & Donors

We categorize private investors and donors cross two dimensions: by type and by philosophy of funding / return expectations.

A key success factor will be how to best match investors and investees across the impact-risk-return equation, which is another reason to have the Sustainability Alliance be an additional intermediary between industrial hemp actors and investors.

		lower ⟸ RETURN EXPECTATIONS ⟹ higher				
		Grants	Guarantees / deposit-backed loans	Concessional Capital	Strategic Investors	Market-return Capital
TYPE	Foundations	x	x	x		
	Family Offices & HNWI*	x	x	x	x	x
	Impact Investors		x	x	x	x
	Agriculture-focused	x		x	x	x
	Funds & Banks				x	x
	Corporations & venture arms				x	x
	Networks			x		x
	Crowdfunding platforms			x		x
	Accelerators					x

* high-net-worth individuals

Government funding is another important source of funding that is not represented in the table as it is its own category, with different instruments, tools, agencies, at both State and Federal levels.

bioSolutions Initiatives will promote the U.S. Hemp Opportunity to all possible funders mentioned here.

Appendix 1: Benchmark of Agriculture Crops

How does industrial hemp compare to the other main agriculture-based crops and to managed forestry?
We consider four dimensions of sustainability: Global Warming Potential (GWP[i]), Water use, Soil impact, and Pesticide use.

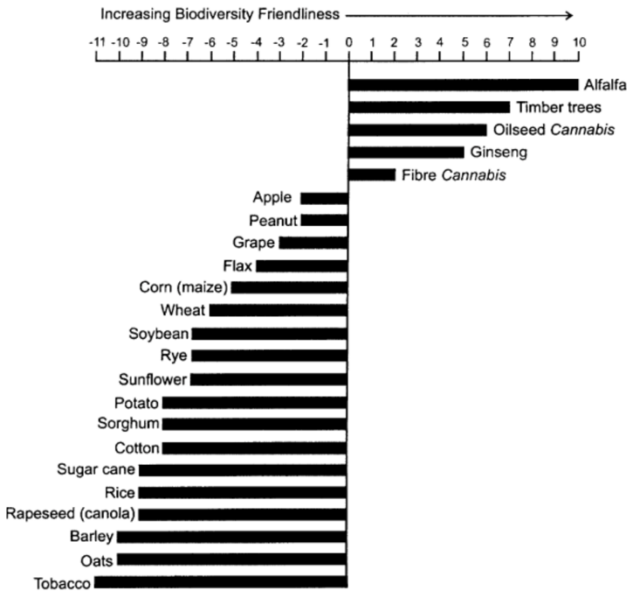
data 2022	U.S. Acres harvested	GWP	Water use	Soil impact	% of global pesticides sales
Industrial Hemp	13,041	-.38	lowest	carbon sequestration + regeneration	0%
Corn	79.2 million	.18	high	negative	11.3%
Soybeans	86.3 million	.8	medium	negative	14.5%
Cotton	7.3 million	1.8	high	negative	4.7%
Sugarbeet	1.1 million	.63	medium	negative	1.3%
Wood	514 million	similar to hemp	lowest	negative	0%

- The negative GWP figure for industrial hemp means it is the only one sequestering carbon apart from wood (their respective performances are relatively comparable).
- Water use is lower than other crops, which supports the case for rotating industrial hemp with common crops, especially in drought-related areas (e.g., cotton states). Not only will the rotation benefit the soil and help retain water, but it will also provide an income to farmers struggling with water availability.
- Hemp's soil benefits are badly needed at a time when soil fertility is decreasing.
- Pesticide use is negligible since no pesticide has been USDA-approved.

We should also consider the hemp potential in terms of acreage: from the small amount farmed today, let us imagine the environmental impact if hemp was used on rotations on just 2.5% of the total acreage of the main U.S. crops (corn, wheat, soybeans, cotton, and sugarbeet). This would represent 5.1 million acres, the equivalent of one-third of the farmed area in the state of Indiana[58].

Although flax is not an industrial crop, it is one of the most successful plants used for composites and textiles (linen) and should be mentioned here. Flax was industrialized during the 20th century. The plant has two major disadvantages, however: first, 80% of its value comes from long fibers, which represent only 20% of the matter; second, the plant is not as resistant as hemp and cannot grow in as many different climates and soils.

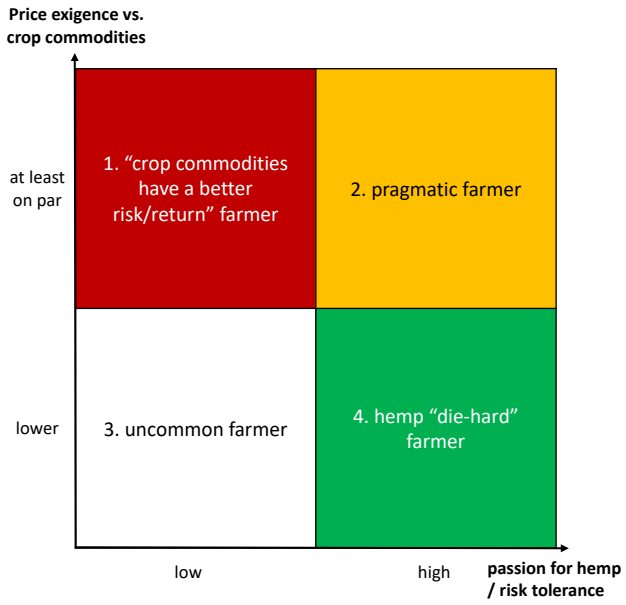
The chart on the right compares the biodiversity friendliness of various crops based on 25 criteria. Industrial hemp grain ("oilseed cannabis") and fiber ("fibre cannabis") show positive scores and are higher than other agricultural crops[59].



[i] measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2). The larger the GWP, the more that a given gas warms the Earth compared to CO_2 over that time period. Thus, a large number means worse in terms of GHG emissions.

Appendix 2a: Farmer Adoption and Retention - Challenges

1. Like any new crop, farmers will be slow to adopt; thus, varied approaches will be necessary to recruit and retain farmers, adapted to local circumstances.
2. The cost and risk of introducing a new crop are high, especially for large farmers benefiting from subsidies and insurance that are not as applicable for hemp.
3. Farmer retention is critical to the success of the industry; a long-term approach allows for securing volumes, generating raw material consistency, and improving quality and yields over time through better agronomics.
4. The economic incentive to the farmer may not be favorable if expressed only in terms of net margins, especially now that commodity crops are priced quite high.
5. Farmers dislike some technical aspects of growing hemp: the lack of agronomic knowledge, the lack of weed management tools, the expenses associated with regulations, the strain on harvesting equipment, the retting process, and the lack of an animal feed market.
6. Farmers need to feel confident they will be able to sell and that hemp processors will be able to buy their harvest and pay on time.



Appendix 2b: Farmer Adoption and Retention – Solutions

Agronomics	Sustainability
1. Large Tier 1 processors need own agronomics team to advise farmers 2. Implement partnerships with Universities 3. Facilitate training on agronomics through in-person trainings and free video programming (youtube.com)	**1. Promote hemp for weed control and disease control (EX: corn and soybean farmers in the Midwest)** **2. Promote hemp for lower water use and drought-resistance (EX: cotton farmers in Texas)** 3. Promote other hemp benefits in a targeted manner: soil health and stability (regen. ag./organic farmers), water retention (dry areas), lower chemical inputs (where farmers'm margins are slim) 4. Communicate that Tier 1 processor and future Tier 2 will bring jobs and revitalize the area
Profit	**Organization**
1. Hemp enables higher yields on subsequent crops and/or lower chemical use, boosting profits **2. Tier 1 to offer timely payments and to propose pricing schemes that either**: a) ensure price stability yoy to differentiate with commodity crop variations (maybe requiring farmer to commit for a min. # of years), b) offer profit sharing (cash or shares), c) create a farmer incentive program based on tiered-volumes or raw material specs 3. Organic and Regenerative Agriculture are fast-growing markets: faster route to consumer awareness and to profitability 4. Possibility of multicropping depending on regions and dual/single use (winter wheat, soybean, etc.)	**1. Encourage farmers to join a Grower Association and create a Farmer Advisory Board at the Tier 1 Processor level to incentivize retention** 2. Harvesting is better managed by the Tier 1 processor 3. Retting: to be further explored; maybe through technology 4. Tier 1 to contract acres from farmers to remove farmer risk and demonstrate hemp's value proposition (treat as acquisition cost) 5. Logistics costs mandate Tier 1 to operate a narrow radius of farmers (~150 miles). However, consider the opportunity to build a network of faithful farmers when the adoption + retention costs are lower (depending on farmer profile); capitalize all farmer acquisition cost (GAAP) to represent it as an asset that will yield long-term benefits. 6. Explore on-site pre-processing to add value for farmers and lower logistics costs.

Appendix 3: Regional Approach for Tier 1 Greenfields

The successful development of the industry will have to consider regional specificities, starting with the adaptation of the hemp genetics to the environment, the crops that hemp will rotate with or replace, the type of farmers, the cost of the land, the conduciveness of the business climate to set up processors, logistics, closeness to markets, etc. Below is a draft of the approach, describing a few of the variables.

	North-West	South-West	South-East	North-East	Midwest
Strengths	• genetics OK	• long / multiple growing season?	• genetics OK • industrial network	• similar climate to Europe (+ rainfall)	• R&D commitment (5 universities) • high land prices
Weaknesses	• large distances • no major industries • retting difficult • staffing difficult	• no genetics (Texas A&M 4-5 year out)	• nascent processors	• no Tier 1 processor	• no processor • no agronomics (3y)
Opportunities	• exports (Seattle / Oakland)	• water scarcity (cotton farmers)	• numerous cotton gins	• high population density: ideal for Tier 2 processors	• animal feed demand • automotive industry • glyphosate weed resistance
Threats				• check regulations • land prices?	• higher corn profitability
Main crops	• Barley, Wheat	• Cotton	• Cotton • Soybean, Corn		• corn • soybean (81% of US)
Tier 1	INDHemp, Whitefield,	Panda, element6 Dynamics, Lonestar, Global Fiber Processing	FyberX, Biophil		Dun Agro, Heartland, Hemp Acres, Tiger Fiber
Tier 2	Healthy Oilseeds, Hempitecture, Hemp Shield	The Hemp Plastic Co., EnviroTextiles, HempFoam	Trace, Bast Fiber Tech, Bastcore, Bear Fiber,	Eaton Hemp	Victory Hemp, Fibonacci, FlexForm,
Industries	• Nutrition (organic?)	• Plastics and oil • Cosmetics	• Textiles • Automotive		• Nutrition • Plastics & Composites

Appendix 4: Innovative Funding Models

In addition to traditional financing instruments, the following models could help address the nascent state of the U.S. Industrial Hemp value chain:

- Sustainable Supply Chain Finance: a form of trade finance based on a Letter of Credit that helps a farmer pre-finance harvest and includes key environmental outcomes.
- Agricultural Lending Incentives: agricultural lenders include favorable terms (duration, rate, flexible repayments, etc.) in their standard loans to farmers for sustainability outcomes.
- Transition Risk Sharing: mitigates the risk involved in shifting to sustainable agricultural practices. This includes sustainability-linked crop warranties, sustainability-linked private crop insurance subsidies, and sustainable reference prices (price floors).
- Pay-for-Performance programs incentivize farmers for the environmental outcomes they provide by adopting conservation practices. The Soil & Water Outcomes Fund is one such mechanism.
- Land Tenure & Leasing Incentives: as many young farmers can no longer acquire highly priced farmland, a mechanism that trades sustainability outcomes for land ownership is worth exploring. The Sustainable Flex Lease is one such scheme targeted at regenerative agriculture practices.
- Revolving Credit Facilities (RCFs), usually renewed every year, include a sustainability-linked pricing mechanism connecting the interest rate with the corporation's performance in meeting annual reduction targets for KPIs (for example, CO_2 emissions, electricity and energy consumption, water usage, and solid waste sent to landfills). Example: Louis Dreyfus.

These models may require the backing in some form of a third party: the Industrial Hemp Sustainability Alliance, investors and guarantors, and Corporations.

Appendix 5: Promoting Hemp to Corporations

A recent McKinsey review of the Global 500 companies shows that most companies have climate-related targets (83%). Across other dimensions of nature, however, targets and acknowledgments are far lower; although 51% of companies acknowledge biodiversity loss, only 5% of those have set specific targets[60]. Other important dimensions, like nutrient pollution, forest and seabed loss, and chemical and plastic pollution, show up even less frequently in corporate targets. This may be attributed to the fact that corporations, broadly speaking and except for those companies linked to agriculture, have little understanding of their impact and linkages to the natural world.

To identify potentially fruitful collaborations with Corporations, it is necessary to review their ESG commitments (SBTi, etc.) while evaluating their vulnerability to supply chain disruptions. Who to contact: Chief Sustainability Officer, Supply Chain Manager, CSR Manager, Chief Marketing Officer, Head of Product Development.

Examples:

- By 2025, fashion and apparel company Kering aims to regenerate 1 million ha of farms and rangelands in their supply chain landscapes through the Kering for Nature Fund, with a focus on the materials with the highest environmental impacts: leather, cotton, cashmere, and wool. Together with the J Crew group, the sustainable cotton platform Cotton Connect, and the nonprofit Textile Exchange[61], they published a comprehensive report detailing years of research into the ways regenerative agricultural practices can help build soil carbon, improve nutrient availability, water holding capacity, and soil biodiversity, as well as resilience to extreme weather and disease, all of which also benefit health and livelihoods in local communities.
- Walmart's regenerative farming investments focus on critical commodities like wheat, soy, corn, and rice. The company has partnered with the Midwest Row Crop Collaborative, a cross-sector initiative helping farmers in the Midwest adopt regenerative agriculture. They target 30,000 farming operations to advance regenerative farming practices across 30 million acres in the Midwest[62].
- The Unilever Climate & Nature Fund, AXA Climate, and Tikehau Capital announced a partnership to explore the idea of an investment tool that will help accelerate the transition to regenerative agriculture and committed to investing €100 million each.
- Even a chemical company like BASF is investing in bio-based composite materials and embracing the circular economy. For example, they formed an R&D partnership with the Chinese company Bochao, an auto parts manufacturing enterprise.
- Champagne company Veuve Clicquot (part of LVMH) launched an industry-first, low-carbon, low-impact, virgin tree-free luxury box with global environmental NGO Canopy[63]. The new eco-friendly packaging, made from 50% recycled paper and 50% hemp, is part of the brand's work to spur innovation and is the latest advance in their commitment to Canopy's Pack4Good initiative. The hemp used is locally sourced in the region of Champagne, France, near the company's vineyards. One of the strongest and most durable fibers in nature, hemp allows the box to be 12% lighter than conventional champagne boxes, bringing savings in both resource use and transportation.
- The SOPREMA Group, a €3.74 billion company producing waterproofing, insulating, and roofing materials, aims to realize a 65% reduction of the waterproofing products' dependence on petroleum-based materials through recycled or renewable resources for economical, sustainable development, and strategic reasons[64].
- 3M announced it will exit per- and polyfluoroalkyl substance (PFAS) manufacturing and work to discontinue the use of PFAS across its product portfolio by the end of 2025. In June 2023, the company reached a $10.3 billion settlement with U.S. cities and towns over their claims that the company contaminated drinking water with so-called forever chemicals used in everything from firefighting foam to nonstick coatings[65]. Companies like Chemours, DuPont, and Corteva similarly agreed on large settlements to remove PFAS from public drinking water systems. This is obviously an opportunity for bio-based materials.
- Materi'Act, an ecosystem launched by FORVIA (the 7th global automotive supplier), aims for an 85% CO_2 reduction through formulating and processing recycled, bio-sourced, and carbon-capturing materials for the automotive industry and beyond.

Appendix 6: Hemp Protein Isolates

Conscious eating is a strong trend, notably among younger generations, and CPG companies are taking note by investing in high-protein foods, plant-based proteins, and overall performance and quality proteins. The global protein market is currently valued at $25.7 billion. As a subset, the protein isolate market amounts to $13.1 billion (or 51% of the protein market). The major isolates are whey and soy, totaling 89%.
The plant protein industry is still fragmented and highly competitive without dominant players, which will allow new entrants to capture market share. The alternative protein market is poised to see a 36% compound rate of growth through 2030.

Hemp protein isolates could represent a $500 million worldwide opportunity by 2028 thanks to the accelerating demand for alternative proteins, particularly in developed economies like the US.

- Hemp isolate is a competitive offer compared to pea, soy, and whey thanks to its competitive pricing, potential for improvement as it reaches scale, and high protein digestibility index, which is important for food formulators and consumers. Moreover, it has the advantage of belonging to the plant-based category (vs. whey) and does not have the issues that soy proteins have (GM crop contamination, especially in Europe, and concerns around allergens and phytoestrogens).
- Environmentally, hemp resists drought better than crops like soybeans and peas; since dairy operations are also highly dependent on water, hemp could possibly present an alternative to whey as well.

Worldwide investments in alternative proteins represented over US$16 billion over the past decade[66]. While there has been some overexuberance, notably motivated by plant-based meat analogues, investors are now taking a more measured approach. A December 2022 global survey[67] of 125 investors conducted by the Good Food Institute (GFI), a non-profit focused on promoting the transition to an animal-free food future, suggests ESG impact is the largest driver of investor interest in alternative proteins; 80% of respondents include alternative proteins in their ESG funds' core mandates. Interestingly, investors now favor the B2B segment instead of B2C.

In summary, the protein market has multiple tailwinds for growth, and its subset, protein isolates, is predicted to grow even faster. With a competitive value proposition, industrial hemp has the potential to seize a decent market share.

A. Market Trends

1.1 Conscious eating is on the rise

Even before COVID struck, consumers of various demographic backgrounds had been experimenting with conscious eating for health and sustainability reasons [68]. The pandemic accelerated the existing trend, prompting consumers to eat fresher, healthier food.

In a McKinsey survey covering the US and some European countries, at least 70% of respondents stated they wanted to be healthier. Food is essential to achieving that goal, and about 50% of consumers across age groups say healthy eating is a top priority for them[j].

- For this half of consumers, this means reducing consumption of processed foods and sugar (their top concerns), as well as fat, salt, and, for some, red meat.
- Younger consumers are more likely to have a longer list of ingredients that they seek to avoid. The 18- to 24-year-old age group prioritizes reducing gluten, red meat, and dairy. It is worth noting that younger consumers report food allergies and intolerances at much higher levels (50% in the U.S.). By comparison, less than 20% of those 35 or older report food allergies or intolerances. The need to manage health issues may play a role in how younger generations are shifting their eating habits.

Plant-based alternatives are a focus for the conscious-eating consumers. About 25% of the survey respondents ate more plant-based products during COVID, while 33% call themselves consumers of plant-based products, especially

[j] https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/hungry-and-confused-the-winding-road-to-conscious-eating

the milk and meat alternatives; another 15% aim to start buying plant-based food in the next year. However, very few plan to exclusively shift to a plant-based diet; indeed, about 50% still prefer the taste of animal protein products over plant-based alternatives. Plant-based foods that consumers find more palatable (e.g., plant-based milk and meat) will grow faster than categories in which taste is still developing (e.g., plant-based cheese). This has implications for CPG manufacturers, as many players look to expand their plant-based offerings.

Consumers are price-sensitive when it comes to their weekly grocery budget, and they demand value for money. With high inflation, consumers face tough choices about the food they buy and consume. As many as 74% of U.S. consumers are changing their shopping behavior to get more for their money, including buying food in bulk, adjusting the quantities purchased, and purchasing a less expensive brand or private label.

1.2 Growing interest in alternative proteins

Historically, protein isolates like casein, albumin, and gelatin have been derived from livestock processing. In the U.S., the growing demand for protein has triggered a rush to develop alternative protein sources from nuts, seeds, legumes, mushrooms, or algae. Manufacturers can choose from various protein sources like hemp, pumpkin, sunflower, flax, and chia.

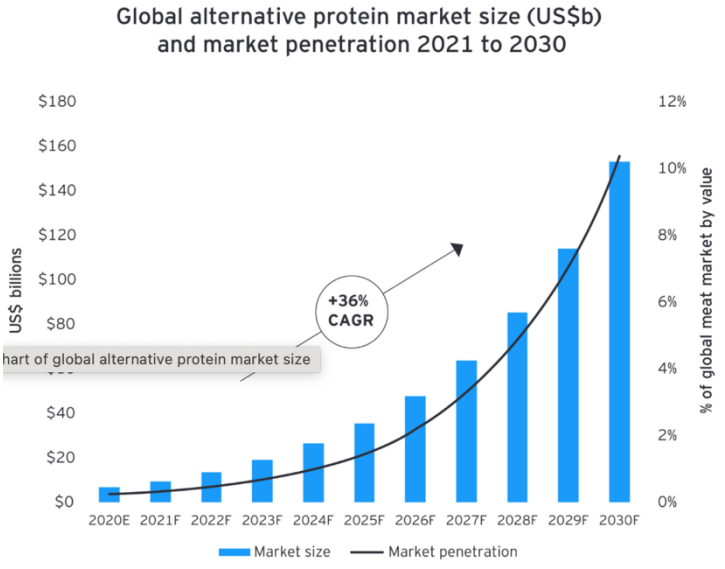
A survey of approximately 800 U.S. consumers to better understand protein usage across a range of products as well as what protein characteristics are of interest to consumers[k] found that 42% of U.S. consumers indicate an awareness toward different protein sources. Among the plant sources, soy protein is the most often acknowledged protein in use (31%), then dairy (25%), rice (23%), hemp (18%), and pea proteins (13%).

Blends of animal and plant proteins or animal and fungal proteins are another approach to addressing consumers' interest in protein diversity. Protein blends are designed to provide the complete protein benefits associated with animal proteins along with the superfood benefits of certain plants and mushrooms (e.g., beef and mushroom burgers).

In high-income countries like the U.S., the demand for protein combined with high disposable income has led to a consumer base that has come to expect high-protein foods. No longer is high-protein content reserved for athletes; mainstream consumers turn to protein nutrition for satiety, weight loss, and muscle building. Given that two-thirds of the population is overweight or obese and a growing senior population is turning to nutrition to mitigate aging (especially muscle loss), proteins meet mainstream needs.

Consumers are looking for more protein in their food and thus check labels for protein content. According to Nielsen, 55% of U.S. households say high protein is an important consideration when they grocery shop.

EY Food and Agriculture practice estimates[l] that alternative protein penetration of the global meat market by volume will climb from <1% in 2020 to between 5% and 10% in 2030 and potentially accelerate afterward. Cost and quality are the critical factors that need to improve; the cost of alternative protein production is expected to fall below the cost of conventional protein production by the mid-2020s and, by 2030, to be less than US$5 per kilogram (to be compared to a global average meat price of US$4.7 per kilogram in 2020).



[k] https://www.ift.org/news-and-publications/food-technology-magazine/issues/2020/october/columns/nutraceuticals-plant-based-protein-market-grows-stronger

[l] https://www.ey.com/en_us/food-system-reimagined/protein-reimagined-challenges-and-opportunities-in-the-alternative-meat-industry

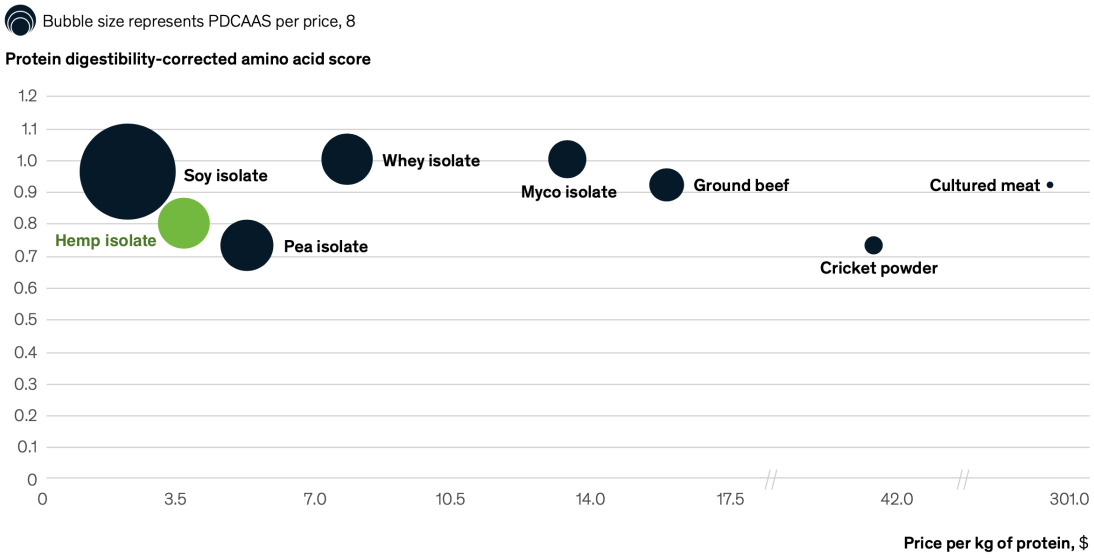
B. The Market for Protein Ingredients and Protein Isolates

2.1 Hemp as a competitive protein

The ingredient industry remains unconsolidated, with many players supplying the food processing industry worldwide.[m] Hemp proteins compete with other more commonly grown crops like soybeans, peas, lentils, and corn as a feedstock for the industry and are a new and minor player.

Specialty food ingredients are meant to modify the characteristics of processed foods: they enrich, emulsify, texture, color, flavor, and stabilize. They are often sold business to business. Protein powder and protein isolates from hemp show promise, especially as formulators look for rheological (textural and form-holding) and functional improvements from novel ingredients.[n] Protein powders differ from isolates by definition; isolates contain above 80% protein by mass, and powders belong to a less refined format.

The chart below[o] shows a comparison of various proteins and protein isolates and shows that hemp isolates have the potential to compete in terms of digestibility and price.



As shown from the table, hemp isolate has strong potential given:

- competitive pricing, which can be further improved when producing at scale.
- high digestibility index, which is important for food formulators.

There are drawbacks to the use of hemp seed protein, but these are many of the same issues as with other plant proteins, including low solubility at a slightly acidic to neutral pH, which limits its functionality in many food-relevant environments. Therefore, new hemp-based food products necessitate the exploration of processing methods to increase the functionality of hemp seed protein.

2.2 Total Addressable Market

We estimate the global protein market to currently be north of $25.7 billion. As a subset, the protein isolate market amounts to at least $13.1 billion (51% of the protein market). The major isolates are whey and soy, totaling 89%. Pea proteins and isolates have been growing fast but still represent a very small share.

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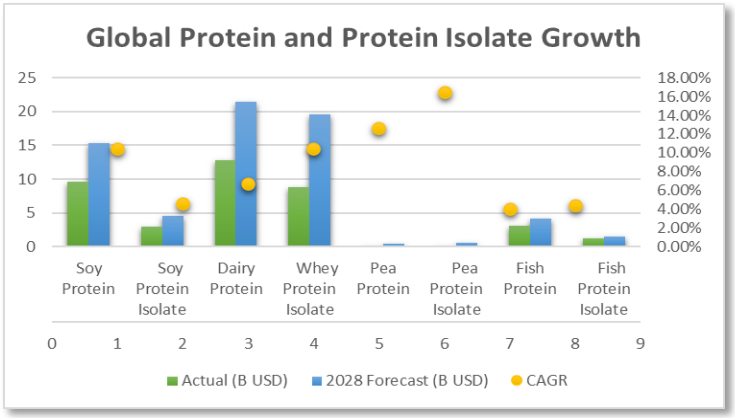
[m] "Food Processing Ingredient Market by Source and Geography - Forecast and Analysis 2022-2026," May 2022, https://www.technavio.com/report/food-processing-ingredient-market-industry-analysis

[n] Simon Okomo Aloo, Godfrey Mwiti, Louise Wanjiku Ngugi & DeogHwan Oh (2022): Uncovering the secrets of industrial hemp in food and nutrition

[o] Alternative-proteins-The-race-for-market-share-is-on - https://www.mckinsey.com/industries/agriculture/our-insights/alternative-proteins-the-race-for-market-share-is-on

Going forward, the forecast for 2030 indicates a global protein market of $41.4 billion and an isolate market of $26.1 billion. The isolate market would then represent 63% of the protein market (up from 51% today), which indicates that isolates are the growth opportunity.

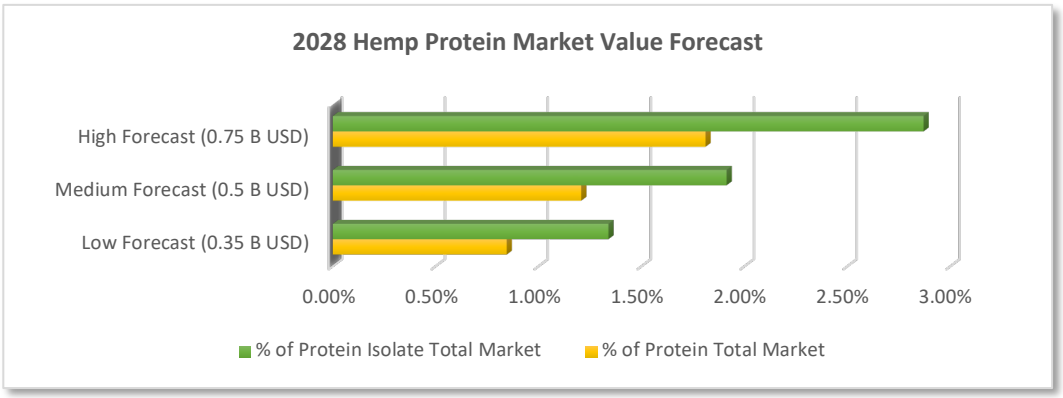
Dairy proteins, including whey and milk proteins, are expected to continue leading in premium applications such as sports nutrition, clinical nutrition, and infant formula. They are considered a complete protein source and offer important advantages over soy proteins in taste and functionality.



Note: the seaweed protein market is estimated to reach $1.5 billion by 2030, growing at a CAGR of 11.6% from 2022 to 2030. We left it out of the TAM analysis for lack of data on isolates.

Hemp has the capacity to gain market share in both the protein and protein isolate markets.

- Our baseline ("Medium Forecast") assumes that 10 companies worldwide will develop and reach, on average, $50 million in revenue from isolates each, representing a $0.5 billion hemp isolate market. This would constitute 2.0% and 1.21% of the isolate and total protein markets, respectively.
- The "Low" and "High" forecasts point to 1% and 3% of the global isolate market, respectively.



2.3 Opportunities for Hemp to Seize Market Share

- Consumers who buy plant-based proteins enjoy the health benefits of those products, but for the health claims to be substantiated, formulators need to access novel ingredients that address the gaps in their texture and nutrition profiles.[p] Hemp protein's exceptional nutritional characteristics make it a perfect pairing for soy and pea proteins. Both of those legumes lack the methionine that hemp supplies, giving hemp an attractive bid to complete the formulations plant-based products require.[q] Hemp's nutritional profile

[p] "Consumer Insights" https://gfi.org/resource/consumer-insights/, 2023
[q] "16 Complete Protein Pairings with Peas," https://www.soupersage.com/complete-protein-pairings/peas.

contains valuable fatty acids, Omega 3 and 6, in an ideal proportion.[r] Those are the same fatty acids found abundantly in fish liver oil; however, hemp grain's flavor is much more pleasing. Hemp maintains amino acid profiles but adds real unique value for its other nutritional and functional effects.

- While soy remains the main plant protein for the nutrition industry, issues of genetically modified crop contamination (especially in Europe) and concerns around allergens and phytoestrogens are shifting manufacturers toward other plants.
- Plant-based proteins in frozen foods still represent only 1.5% of the $95 billion frozen food sector.
- Sports nutrition consumers understand the concept of protein quality and their impact on physical performance. For example, fast-absorbing whey proteins are popular for post-workout muscle building and maintenance, while slow-absorbing milk proteins are known for providing sustained release and satiety. In the U.S., dairy remains the preferred protein choice for beverages.
- Busy consumers are also on-the-go consumers and protein snacks are a format that works well with this lifestyle. Portable protein snacks can be consumed at work, in the car, at the gym, at school, or outside while jogging or hiking. A snack with protein offers consumers a healthy snacking option and provides satiety, as well as exercise support benefits.
- Protein-fortified bars and ready-to-drink beverages are perennial favorites among on-the-go, snacking consumers, with protein waters emerging as an important emerging category. Seed and nut snack packs, jerky, string cheese, and squeezable nut butters and yogurts are other easy options for portable protein. Small portion sizes and single-serve packaging are key to supporting portable snacking.
- Sustainable proteins have been largely supported by Millennials and Gen Z. as they align with their values. They require less land or fresh water to produce or are associated with fewer CO_2 emissions. For example, proteins from climate-resistant crops (like drought-tolerant millets in India and quinoa in Bolivia), proteins from grass-fed animals or dairy, and upcycled proteins from food production side streams associated with regenerative agriculture.
- Sports performance consumers are driving the demand for protein-based bioactives[69], due to their benefits on muscle synthesis and endurance. Weight management is another market opportunity for bioactives, given the increasing obesity rates globally. Protein-based bioactives can also support immunity and skin health; for example, collagen-boosting bioactives are used in anti-aging facial products.

C. Investor Trends: From Hype to a More Measured Approach

Over the past decade, US$16 billions of investments went into alternative proteins, with an estimated 1,000+ startups worldwide. Investors continue to be optimist about the long-term outlook despite recent failures and a 42% drop in funding in 2022 to $2.9 billion (vs. a 35% decline in overall global venture funding), according to Pitchbook data.

The December 2022 global survey of 125 investors conducted by the Good Food Institute (GFI), a non-profit focused on promoting the transition to an animal-free food future, suggests ESG (environmental, social, and governance) impact is the largest driver of investor interest in alternative proteins; 80% of respondents include alternative proteins in their ESG funds' core mandates.

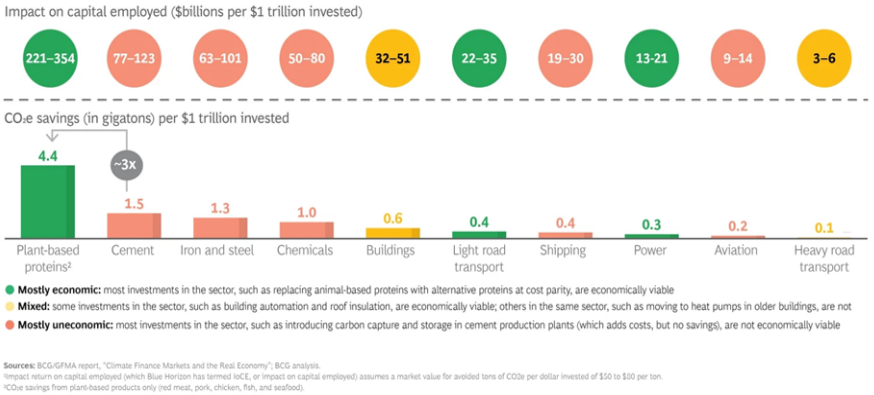
- 81% of respondents were already invested in alternative proteins, with 87% expecting to make further investments in 2023.
- Interest in plant-based products is dwindling, with more firms planning to invest in fermentation-derived products.
- Investors are diversifying their alternative protein holdings with greater emphasis on business-to-business (B2B) ingredients and equipment versus business-to-consumer (B2C).

"We are increasingly seeing investors wanting to diversify from solar and batteries to food, so food and agtech really are next for those ESG investors. We also found 42% of investors cited ESG factors as being a primary driver of interest… When it comes to business models, we're also seeing that more investors want to invest in b2b companies working in ingredients and equipment." - GFI startup innovation specialist Audrey Gyr.

[r] House, Dr. James D., *Evaluating the Quality of Protein from Hemp Seed and Hemp Seed Products Through the use of the Protein Digestibility Corrected Amino Acid Score Method.* August 2007.

Finally, as financial professionals seek opportunities to impress their shareholders with impact statements on the climate, studies are showing that investment dollars in alternative proteins have some of the greatest influence on negative climate effects.[s]

Exhibit 1 - Plant-Based Proteins Have Greater Impact on Capital Employed[1] Than Other Decarbonization Levers in All Other Sectors



Sources: BCG/GFMA report, "Climate Finance Markets and the Real Economy"; BCG analysis.
[1]Impact return on capital employed (which Blue Horizon has termed IoCE, or impact on capital employed) assumes a market value for avoided tons of CO2e per dollar invested of $50 to $100 per ton.
[2]CO2e savings from plant-based products only (red meat, pork, chicken, fish, and seafood).

D. Risks

4.1 Legal & Regulations

- No issues have affected protein isolate makers so far due to loose regulation by the FDA; protein supplements are not regulated by the FDA for safety and effectiveness. Manufacturers must only submit a GRAS notification to the FDA.
- Nonetheless, legal issues or stricter regulations could appear at some point. For example, nonprofit Clean Label Project released a report about toxins in protein powders: 134 products were analyzed for 130 types of toxins and were found to contain heavy metals (lead, arsenic, cadmium, and mercury), bisphenol-A (BPA, which is used to make plastic), pesticides, or other contaminants with links to cancer and other health conditions. Some toxins were present in significant quantities. For example, one protein powder contained 25 times the allowed limit of BPA[t].
- Half of the states in the U.S. have introduced or passed legislation to prevent plant-based and cell-cultured protein products from being labeled as meat or beef. This could have sales repercussions depending on who the buyers of protein isolates are and what type of products they manufacture and commercialize.

4.2 Health and Consumer Perceptions

- There is a disconnect between consumers' demand for organic, "whole foods", and plant-based options, which are perceived as healthier and safer: 50% of consumers[u] believe that plant-based products are artisanal as opposed to highly-processed, and 4 in 10 shoppers think plant-based foods only contain natural ingredients; 49% of customers[v] who buy plant-based foods state they believe plant-based alternatives are healthier than animal-based foods.
- Most of the new products hitting the market are lab-designed and/or highly processed. Processing proteins affects their nutritional profile, and processed foods typically use FDA-compliant chemicals, that nonetheless would not be considered safe by the public (some are even forbidden for human consumption in the EU, India, and other countries).
- For example: methylcellulose (an emulsifier and thickening agent), ferric phosphate (pesticide) or propylene glycol (e-cigarette) are chemicals that can be found in meat-alternative products.
- The health impact of protein isolates has not been determined, and it will likely take at least 10 years to determine their consequences on the human body.

[s] Benjamin Morach et al., The Untapped Climate Opportunity in Alternative Proteins, 8 July 2022, https://www.bcg.com/publications/2022/combating-climate-crisis-with-alternative-protein.
[t] https://www.health.harvard.edu/staying-healthy/the-hidden-dangers-of-protein-powders
[u] UK-based Gosh! Report – goshfood.com - 2021
[v] https://www.plantbasedfoods.org/pbfi-kroger-plant-based-migration-analysis-report/

- As consumers become more health-conscious, they scrutinize more intently how the products they purchase are manufactured, which creates risk in terms of sales or reputational backlash for CPG companies. An ADM study[w] found that 60% of consumers say recognizable ingredients influence their purchase decision, and 66% say they are looking for labels with the shortest ingredient list. These numbers are likely to rise, meaning successful plant-based formulations must exhibit shorter ingredient lists made of natural sources such as beans, lentils, legumes, quinoa, amaranth, and sorghum.

4.3 Technology and Processing

- More research and development into current plant protein refining processes shows those processes often deform the resulting product, decreasing bioavailability and nutritional value[x]. Hemp protein powder ranked among the worst for its digestibility, and anti-nutritional factors are high in seeds like hemp. These present a significant obstacle compared to more developed plant proteins like soy and pea.
- Genetic development of hemp grains that are specific to human consumption will reduce these factors, as has been true for other proteins, particularly yellow pea. As these techniques disrupt the plant protein industry, hemp grain protein producers would do well to keep their methodology on the cutting edge, ensuring the highest-value product on the market.
- Historically, protein isolates like casein, albumin, and gelatin have been derived from livestock processing.[y] Formulators are already seeking novel isolates of specific amino acids from plant proteins. Hemp grain's ability to reduce platelet aggregation[z] and reduce hypertension[aa] may also give it a strong place in ingredient markets in the future. In addition to the substitution of animal-based isolates, high-tech manufacturing processes are currently disrupting the nutrient and pharmacological industries by developing micro and nano-particle protein structures for efficient nutrition uptake, as well as higher shelf stability for drug compounds and foods. Volatile drug compounds in the future will be mostly delivered by highly engineered protein ingredients.[bb]
- As these novel techniques disrupt the plant protein industry, hemp processors would do well to keep their methodology on the cutting edge, ensuring the highest value product on the market.

4.4 Affordability

- Since economies of scale are not yet present, plant-based meat products cost at least twice the amount of other real meat products, at least the typical factory-farmed varieties that most consumers eat.
- By 2030, the cost of alternative protein production (plant-based, cell-based and fermentation) is expected to be less than US$5 per kilogram, while the global average meat price is expected to increase from US$4.7 per kilogram in 2020 to more than US$5.2 by 2030.
- Pea protein has become an attractive plant protein for manufacturers who wish to avoid the issues surrounding soy. Though the pea protein market is still small, at just a fraction of the soy protein market, it is rapidly expanding to meet demand.

4.5 Supply Chain Complexity creates vulnerability

- Compared to basic proteins (meat, fish, etc.), the manufacturing supply chain for protein isolates is more complex and, in the case of plant-based proteins, adds to the risk of climate-related events. For example, the plant-based meat supply chain was disrupted during the COVID pandemic.

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[w] https://www.adm.com/en-us/news/news-releases/forecast-from-adm-highlights-seven-plant-based-protein-trends-to-watch-in-2020/

[x] https://www.foodnavigator.com/Article/2023/01/06/protein-quality-evaluation-halves-environment-impact-of-meat-and-dairy?utm_source=newsletter_daily&utm_medium=email&utm_campaign=13-Jan-2023&cid=DM1051802&bid=21062764#

[y] https://www.marketsandmarkets.com/Market-Reports/speciality-food-ingredients-market-252775011.html#:~:text=The%20global%20specialty%20food%20ingredients,5.8%25%20during%20the%20forecast%20period

[z] Richard MN, Ganguly R, Steigerwald SN, Al-Khalifa A, Pierce GN. *Dietary hempseed reduces platelet aggregation*. J Thromb Haemost 2007; 5: 424–5.

[aa] Abraham T. Girgih, Preventive and treatment effects of a hemp seed (Cannabis sativa L.) meal protein hydrolysate against high blood pressure in spontaneously hypertensive rats. 12 November 2013

[bb] https://doi.org/10.1186/s12951-021-00896-3

Appendix 7: Hemp Myths and Misconceptions

Various inaccuracies and plain propaganda surround hemp. Here are a few of the most notorious examples.

- Henry Ford's "hemp car": contrary to a wildly distributed piece of propaganda, the so-called "hemp car" was mainly "…soybean fiber in a phenolic resin with formaldehyde used in the impregnation"[70] and contained hemp (about 10%) solely as one of several natural fibers.
- In 1850, about 75% of the world's textiles were made from hemp, the strongest fiber; actually, by the end of the XIXth century, cotton was the most used fiber (74%), followed by wool (20%) and linen (6%)[71].
- The 1914 10 Dollar Bill was printed on hemp paper. Crane Currency has held a monopoly on the production of banknotes since the American War of Independence. The paper money is based on 75% cotton and 25% flax and has never used hemp.
- Benjamin Franklin pioneered hemp paper: while he was involved in facilitating the collection of used clothes (cotton and linen) for the manufacturing of paper, there is no record that he was himself a paper manufacturer or involved in hemp[72].
- The Constitution was written on hemp paper: the final versions of the Constitution and the Declaration of Independence were written on parchment[73], not hemp. Hemp was indeed used for paper, so it is possible that drafts of both documents may have been written on hemp paper.
- Hemp has 25,000–35,000 known usages: this is probably a concept borrowed from a 1938 Popular Mechanics magazine article[74]: "Hemp is the standard fiber of the world. It has great tensile strength and durability. It is used to produce more than 5,000 textile products, ranging from rope to fine laces, and the wood 'hurdes' remaining after the fiber has been removed contains more than 77 percent cellulose and can be used to produce more than 25,000 products, ranging from dynamite to cellophane." While the number of uses might be quite numerous, viable commercial applications are probably fewer.
- The first jeans were made from hemp: the cotton industry established itself in the north-east of the United States at the end of the XVIIIth century and the beginning of the XIXth, producing jeans and denim. While hemp may have been used, it would have been mixed with cotton and linen.

Appendix 8: are the ABCD multinationals involved in industrial hemp?

The information below was collected online and may not be fully accurate or comprehensive.

- ADM: through its subsidiary ADM Labs, the company became involved in hemp in Colorado, mainly floral hemp for CBD. A lawsuit between Colorado Cultivars, a hemp farm and processing plant, and ADM Labs took place in 2019. Colorado Cultivars eventually dissolved in 2021. In March 2023, ADM launched the Knwble Grwn product line, which is branded as a regenerative agriculture product line containing flaxseed, hemp seed, flax oil, hemp oil, and quinoa[75].
- Bunge: no reference found.
- Cargill: no reference found.
- Louis Dreyfus: no reference found.

These large multinationals typically buy value chains instead of creating them. While we do not expect the ABCD corporations or their venture arms to significantly participate in the early funding of the industrial hemp value chain (before the growth phase starts in 2030), we should consider them as potential funders later.

In addition, it seems that chemical companies are especially interested in the U.S. Environmental Protection Agency granting registrations for pesticides that can be used on industrial hemp. For example, Syngenta has been lobbying Congress[76] in that regard.

Appendix 9: Job Creation

The USDA BioPreferred Program concluded that for each job in the bio-based product industry, 1.79 additional jobs were created in other sectors of the economy[77]. These statistics excludes food and feed for which we used statistics from the Economic Policy Institute[78], which indicated 2.9 induced jobs for animal food manufacturing and an average of 2.21 for food manufacturing.
Applying those multipliers to the specific sectors (bio-based materials, food, and feed) calculated in the Total Addressable market in 2030 produces an average multiplier of 3.21 (i.e., 2.21 induced jobs per direct job).

Job Creation by 2030 (non-farm)	
Genetics firms	21
Tier 1 - Total	0
Tier 1 - Large	910
Tier 1 - SME	138
Tier 2 - Total	0
Tier 2 - Large	340
Tier 2 - SME	228
Tier 3	300
Sustainability Alliance	7
Other*	600
TOTAL Direct	2,544
TOTAL with induced (x3.21)	**8,166**

** Machinery, logistics and R&D firms and organizations*

Appendix 10: U.S. Addressable Market in Priority Sectors - Assumptions

Sectors	Sub-sectors	US Market Size (b$) current	Baseline Year	CAGR	US Market Size (b$) 2030	TAM %	TAM (b$) 2030	SAM %	SAM (b$) 2030
Plastics & Composites	Plastics & Resins	$129.10b	2022	3.34%	$167.89b	3.44%	$5.77b	16.00%	$0.92b
	Composite Materials	$26.70b	2019	3.80%	$40.24b	8.00%	$1.38b	6.00%	$0.08b
	Foams	$7.60b	2021	5.80%	$12.62b	10.00%	$1.26b	12.00%	$0.15b
Textiles & Nonwovens	Textiles	$65.80b	2022	-0.27%	$64.39b	15.17%	$9.77b	8.00%	$0.78b
	Nonwovens	$8.40b	2021	6.10%	$14.31b	11.58%	$1.66b	12.00%	$0.20b
Construction Materials	Construction Materials	$70.15b	2022	-0.41%	$67.90b	5.00%	$3.39b	10.00%	$0.34b
	Insulation	$10.10b	2022	-2.76%	$8.08b	5.00%	$0.40b	12.00%	$0.05b
Pulp & Paper	Pulp & Paper	$59.54b	2021	2.20%	$72.42b	5.04%	$3.65b	8.00%	$0.29b
Food	Food	$947.30b	2022	3.66%	$1,262.92b	2.60%	$32.84b	2.45%	$0.80b
Feed	Pet food	$58.10b	2021	5.92%	$97.51b	12.56%	$12.25b	10.00%	$1.22b
	Animal Feed	$72.60b	2018	2.40%	$96.50b	12.03%	$11.61b	4.00%	$0.46b
TOTAL		**$1,455.39b**		**3.21%**	**$1,904.79b**	**4.41%**	**$83.98b**	**6.32%**	**$5.31b**

TAM represents the potential market demand regardless of constraints or obstacles like regulations, product readiness, technology, or production capacity. SAM includes all those constraints. Both TAM and SAM follow the general assumption that hemp can be blended into existing materials and ingredients.

The final SAM number may not appear very high in comparison to the revenue projection for 2030. Let us keep in mind that hemp is a novelty that is progressively being integrated into manufacturing while processing and technology are being develop in parallel. Therefore, we anticipate the SAM will keep expanding.

Plastics & Resins

Opportunities for bioplastics, especially for flexible and rigid packaging, are growing although they represent only 1% of global manufacturing volumes[79]. The common feedstocks used to produce bioplastics include corn, wheat, and sugarcane. Hemp can be blended to create new bioresins and bioplastics like sheet and laminates, food-, pharmaceuticals- and cosmetic-grade containers, textiles and fabrics, various consumer goods, etc. The bioplastic market in North America represented $1.53 billion in 2018[80] and the global trends indicate strong growth (11.7%[81]) thanks to high profitability and demand, which could potentially lead to a TAM of $5.77 billion in the U.S.

Composites Materials

The major opportunity in composites is in the automobile sector, for car dashboards and panels. Other possibilities for natural fibers have been developed for boat hulls, skis, kayaks, etc. To add resistance and reduce weight, flax and hemp are the best choices; hemp and flax fiber composites outperform aluminum, steel, and glass fiber composites in terms of specific bending stiffness and have a much lower density than glass or carbon fibers; moreover, they have vibration and sound dampening effects, is particularly valued in sports and leisure because it can help prevent musculoskeletal injury. But this is also true for acoustic insulation, as hemp also absorbs mechanical vibrations the air, also known as sound. The natural fiber composites global market was $4.2 billion in 2022 and projected to grow at a 7.3%[82] rate. Since the U.S. represent approximately 20% of the market, this would represent a $1.38 billion U.S. TAM by 2030.

Foams

Bedding constitutes the entry market for industrial hemp into the flexible foam sector. From there, its application can expand to furniture and upholstery in the home goods and transportation sectors (automotive, planes, etc.). Packaging and construction are additional potential applications. The U.S. foam market was $7.6 billion in 2021 and projected to grow at 5.8% annually[83]. We assume the TAM to be 10% of the total market given technical limitations (the amount of hemp that can be blended) and the fact that not all sectors might make use of the performance improvements brought by hemp. Thus, the TAM will be at $1.26 billion by 2030.

Construction Materials

We take here into account only drywall and floor materials, both residential and nonresidential, estimated at $70.15 billion in 2022[84] and projected to grow -0.4%. We assume that natural fibers can capture 5% of that market for a TAM of $3.39 billion.

Insulation

Insulation materials for both residential and nonresidential uses were estimated at $10.1 billion in 2022[85] and projected to grow -2.8%. We assume that natural fibers can capture 5% of that market for a TAM of $0.4 billion.

Pulp & Paper

The production of paper overall has decreased in the U.S., although the country remains the largest producer after China[86]. The case materials segment (53.6% of total) is however growing, while graphic-paper has plummeted due to digitalization. Assuming hemp could capture 10% of the case material segment that we estimate to grow around 2.20% per year[87], the TAM would be $3.65 billion by 2030.

Textiles

Out of the $65 Textiles market indicated in the table above, the U.S. cotton industry is valued at $21 billion, and hemp could be blended for a conservative 30%, representing $6.3 billion. In addition, we assume hemp could substitute 8% of the non-cotton market (synthetic textiles mainly but also other natural fibers), representing a $3.47 billion opportunity. Total: $9.77 billion, representing a TAM of 15.2% of the market.

Nonwovens

Geotextiles and hygiene (feminine care, baby care, etc.) are strongly growing segment for natural fibers (cotton, jute, flax, hemp, etc.) that represented only 7%[88] of the ingredient mix in 2021. Given the sustainability imperatives, we assume that natural fibers will grow at twice the projected 6.1% CAGR of the nonwovens sector[89], for a TAM of 11.6% of the market at $1.66 billion.

Food

The TAM is large when considering that the 2030 forecast indicates a global protein market of $41.4 billion and its subset, the isolate market at $26.1 billion. Assuming again a conservative 20% for the U.S., these would represent $8.3 and 5.2 billion, respectively. We would need to add the different food segments like confectionery and snacks ($304 billion today, growing at 3.09%), edible oils (7.81 billion today, growing at 3.34%), milk substitutes ($3.6 billion, growing at 8.44%), etc.

Therefore, calculating a TAM for hemp-based foods is a complex exercise that is beyond the scope of this paper. We will focus on the SAM instead.

Hemp-based food sales in the U.S. reached $137 million in 2019 and were projected to reach $186 million in 2022[90], a 10.7% CAGR. Market research firms have projected the global hemp-based food market to be anywhere between $7 billion in 2027[91] to $11.6 billion by 2029[92]; assuming the U.S. conservatively represented 20% of the global market, hemp-based foods could represent between $1.4 billion in 2027 to $2.3 billion in 2029.

Our estimates are more conservative, aiming for $0.9 billion in 2030. Indeed, most hemp-based food is imported to the U.S., therefore farming and production capacity will need to be ramped up quite drastically to meet the demand, even if hemp ingredients are blended and only represent a small share of the finished product. Moreover, the U.S. main market, raw hemp seeds, is probably nearing saturation; future growth will be through blending hemp into value-add products (plant-based meat, bakery, beverages, confectionery, oil-based ingredients, and protein isolates). For this, investing in application development will be required, in order to commercialize an attractive value proposition to formulators.

The protein isolate market represents a great opportunity to be developed (see *Appendix 6*). Assuming a global $500 million market by the end of the decade, the U.S. could easily represent 50% (based on the current share in the plant-based protein market), thus $250 million. The remainder of the hemp-based food market (i.e., $553 million) will be composed of raw hemp seeds sales ($182 million) and value-add products ($371 million).

For comparison, by 2030, the $803 million hemp-based foods SAM will represent only 25% of the U.S. almond market[93], although being a raw food that can also be processed into a wider range of value-add products. Another comparison would be chia seeds, whose current market is approximately the same size as hemp-based foods (in 2020, the U.S. imported around $168.9 million[94]) and with a CAGR of 8.4%, would grow to $378 million by 2030.

Pet food

The natural pet food segment is projected to grow to $12.25 billion[95] by 2027, so will we use this as the TAM within the total U.S. pet food market ($58.1 billion[96]).

Animal Feed

The US animal feed market size was about US$72.6 billion in 2018 and is expected to grow at a CAGR of 2.4%[97]. According to a market research report[98], the global sustainable animal feed market was valued at $10.6 billion in 2021 and was expected to reach $58.03 billion by 2030 (CAGR of 21.2%). Assuming the U.S. would represent 20% of that market, it would represent a $11.6 billion TAM.

Calculating the SAM

To calculate the serviceable addressable market by 2030, we affected the following percentages to the TAM.

- One criterion is the complexity of bringing the products to market, whether because of regulations, technology, processing, or raw material consistency. The lower the complexity, the higher the % of TAM can be captured by 2030.
- The second variable is the imperative from buyers to get that product. The impact is not as strong as the one attached to complexity but is still represented ("where there is a will, there is a way").
- The only exception is food, where we calculated the SAM bottom-up, as the market includes too many sib-segments with various dynamics.

SAM Categories	ESG Vulnerability / Sustainability imperative		
Complexity to bring to market	low	medium	high
High	• Animal Feed	• Composite Materials	• Textiles • Pulp & Paper
Medium		• Construction Materials • Food • Pet food	• Nonwovens
Low	• Insulation • Foams		• Plastics & Resin

SAM %	ESG Vulnerability / Sustainability imperative (+2% per easier grade)		
Complexity to bring to market (+4% per easier grade)	low	medium	high
High	4%	6%	8%
Medium	8%	10%	12%
Low	12%	14%	16%

Appendix 11: Next Steps Overview – Gantt chart

	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24
1. RAISE AWARENESS AROUND THE U.S. INDUSTRIAL HEMP OPPORTUNITY – 2023													
1. Promote this report to donors, investors, government agencies, corporations & their venture arms, and farmers			operational funding secured										
2. Refine investment thesis from the feedback received			revision 1		revision 2								
3. Build a shortlist of potential donors, investors, and partnerships for the Industrial Hemp Sustainability Alliance (initiative #3) and for the Blended Capital Fund (initiative #4.2)													
2. INSTITUTE ROUNDTABLE TO SPEARHEAD STRATEGIC INITIATIVES – 2023													
1. Attracting capital													
2. Policies, regulations, and industry branding / image													
3. Federating & de-risking the industry; governance													
Goal: define and prioritize initiatives under the U.S. Industrial Hemp Accelerator; some will be integrated in the Industrial Hemp Sustainability Alliance's programs (initiative #3).	pre-launch	1st meeting			1st-pass strategy			5-6 initiatives defined			1st ops. results		
Who: processors, associations, farmers, and financiers who are leaders in industrial hemp													
3. ESTABLISH the INDUSTRIAL HEMP SUSTAINABILITY ALLIANCE – 2023													
1. Tactical: 5-8 Tier 1 processors gather to address 2-3 operational issues (standards, etc.)		1st meeting			progress review			1st ops. results			progress review		
2. Organizational:													
• legal entity set-up + staffing + Board													
• define goals & activities for 2024-2025 and refine budget													
• membership structure + fundraising for the Alliance								first grant secured					
• coordination with NHA, NIHC, USHBC, and other associations						formalize							
4.1 INTERMEDIATE DIRECT INVESTMENTS – 2023													
• evaluate companies													
• pitch funders													
4.2 LAUNCH BLENDED CAPITAL FUND – 2024													
• form Advisory Board													
• define investment approach													
• develop theory of change													
• build pipeline of investable projects													
• financial modeling													
• risk mitigation / investment readiness													
• define fund terms													
• target capital sources							2-3 anchors secured						close
4.3 ACTIVELY CO-INVEST with OTHER FUNDERS													
• rePlant Hemp													
• etc.													
5. MARKETING CAMPAIGN – 2024													
1. Assuming favorable outcome from Farm Bill 2023, communicate nationally about the approved changes regarding Industrial Hemp's status and regulations						marketing campaign							
2. Communicate about the Industrial Hemp Sustainability Alliance's initiatives													
3. "One Plant" documentary film release - www.oneplant.film													festivals
4. Consider industry trademark for North American-sourced, North American-made industrial hemp products													

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