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Market Study and Value Chain Analysis of **INDUSTRIAL HEMP** in Nigeria

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ACRONYMS AND ABBREVIATIONS

ABS	Anchor Borrower Scheme
ADP	Agricultural Development Program
AFAN	All Farmers Association of Nigeria
COPMAN	Cotton Producers and Merchants Association of Nigeria
CBD	Cannabidiol
FCT	Federal Capital Territory
FGDs	Focused Group Discussions
FMARD	Federal Ministry of Agriculture and Rural Development
FRIN	Forest Research Institute of Nigeria
IAR	Institute for Agricultural Research
IAR&T	Institute for Agricultural Research and Training
IH	Industrial Hemp
LSF	Large-scale farmers
MDA	Ministries, Departments, and Agencies
MSF	Medium-scale farmers
NACOTAN	National Cotton Association of Nigeria
NAERLS	National Agricultural Extension and Research Liaison Services
NASC	National Agricultural Seed Council
NBS	National Bureau of Statistics (Nigeria)
NDLEA	National Drug Law Reinforcement Agent
NEMA	National Emergency Management Agency
NESREA	National Environment Standard and Regulation Enforcement Agency
NIRSAL	Nigeria Incentive-based Risk Sharing System for Agricultural Lending
NNPC	Nigerian National Petroleum Corporation
SHF	Smallholder Farmers
TCT	Tetrahydrocannabidinol
VCA	Value Chain Analysis

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Executive Summary

The global appeal of Cotton has made it increasingly difficult for farmers to shift into sustainable fabric production alternatives irrespective of the climatic implication of its production. It is assertive to mention that the imminent ban on exporting agricultural commodities in plastic bags will continue to ensure the rise in Cotton production in Nigeria, notwithstanding the damming consequences on the environment. This ban is expected to stimulate demand for Cotton-based sacks, which is expected to trigger Cotton production across Northern Nigeria. Considering climate change's effect on agriculture in Northern Nigeria, additional degenerative production practices will exacerbate the downward spiral and harm the environment even more. However, industrial hemp has been suggested as fibre alternative in Northern Nigeria to alleviate this constraint while ensuring adequate economic benefits.

Persuading farmers to substitute industrial hemp on acreage traditionally planted in crops like Cotton has not been easy due to the lack of enterprise budget data, traditional beliefs, rigid government policy, and lack of political will. However, the desirable features are yet to be explored, hence the need for this project. The broad objective of the project is to assess how cotton can be substituted with industrial hemp in Nigeria to meet local and international market demands for national growth and development.

The fieldwork was conducted in eleven (11) states across northern and southern Nigeria to collect data on Industrial Hemp (IH) from stakeholders in the value chains. There was tremendous difficulty in acquiring information on industrial hemp in these states. Although we eventually secured unstructured, informal interviews with some industrial hemp actors in Ondo state through a contact at the state AFAN office. We adopted mixed methods in undertaking the study. Data and evidence collection involved the use of various tools and resources, including desk review of literature, reports, relevant documents, online databases, and publications, as well as interviews with key actors at all stages in the fibre crops value chain on themes related to the study's specific components of functional, economic, social, and environmental issues.

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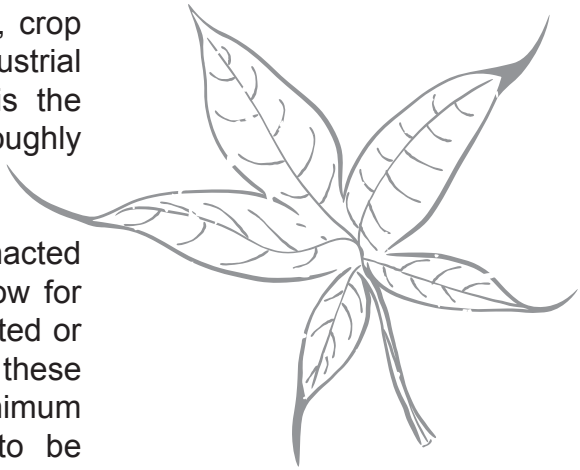
Production of Industrial Hemp: The key players in the industrial hemp value chain are the US, Canada, China, and the EU. No official data exist on current production volumes, crop differentiation (fibre or seed), or trade-in differentiated industrial hemp products. Still, most sources agree that China is the dominant global supplier of industrial hemp, producing roughly 70 percent of global output.



More than 30 countries and at least 47 US States have enacted legislation to establish hemp production programs or allow for hemp cultivation. At least ten African countries have enacted or are enacting a legal framework for industrial hemp.In all these locations, industrial hemp cultivation is subject to a minimum level of THC content, which allows industrial hemp to be differentiated from its narcotic cousin, marijuana. In all these countries, industrial hemp is regulated, even if it is legally permitted.

The important point is that industrial hemp cultivation remains a minor and insignificant crop globally and in national agricultural statistics. Also, the industrial hemp market (even from the supply side) cannot be seen as a homogeneous market, as the plant is cultivated for fundamentally different end uses. Hemp is a multi-use, multi-functional crop that provides raw materials for many traditional and innovative industrial applications. For each end-use destination, there are specific characteristics and quality requirements for the properties of the bast fibres, the oil, the protein in the seeds, and the profile of secondary metabolites such as CBD. The heterogeneous nature of the plant and its crop suggests that, when entering the industrial hemp cultivation market, understanding the end use of the hemp input will be crucial in decision-making from seed selection onwards.

The method of harvesting is similarly determined by the envisaged end use of the plant. When grown for fibre, the whole plant needs to be harvested. This is traditionally done by hand in developing countries mainly because industrial hemp plant stalks are thicker and stickier than the types of stalks modern combine harvesters are designed to harvest. Because there has been no commercial-scale cultivation of industrial hemp for over five decades, purpose-built industrial hemp machinery has not been developed.

Industrial hemp end-uses. Hemp fibres are predominantly used in textiles, paper manufacture, and— more recently and notably—in bio-composites. Hemp seeds. Industrial hemp offers the second-highest source of protein in the plant kingdom. **Hemp seed** oil is the oil obtained by cold expression from the ripened fruits (seeds) of Cannabis sativa. Once the oil has been extracted from the seed, the residual matter is known as oilseed cake or seedcake. Because of its high residual protein content and amino and polyunsaturated fatty acids, seedcake makes an especially good animal feed. **Hemp hurd.** The plant's woody inner core, the hurd, makes **high-quality animal bedding** because of its super absorbent properties.

Commercial viability. There is substantial disagreement over whether industrial hemp is more commercially viable as a dual-purpose crop than a single-end-use crop, merely adding to already complex cultivation and usage decision. The selling price of upstream and downstream products is the key to any opinion on commercial viability. As with any agricultural crop or feedstock, market prices increase as value is added down the value chain. We observe high variation in absolute values for different products, although the relative values for the downstream uses are consistent. The hurd is the least valuable processed output, followed by fibres, oil, and seeds. At the same time, the secondary processing and increased value addition appear to minimise the consistency of price differences across the locations, reflecting the different uses and demand. The two most significant demand drivers for industrial hemp end-use products outside China are industrial hemp seed as **a health food input** and industrial hemp as **a source of CBD oil.** Furthermore, studies show that the proposition of industrial hemp as a crop with enormous opportunities for growth falls into three groups; adaptability to different agroecology, environmental concerns, and Health and food safety concerns.

Industrial hemp is a safe substance with many practical commercial applications.

. . . Cory Gardner

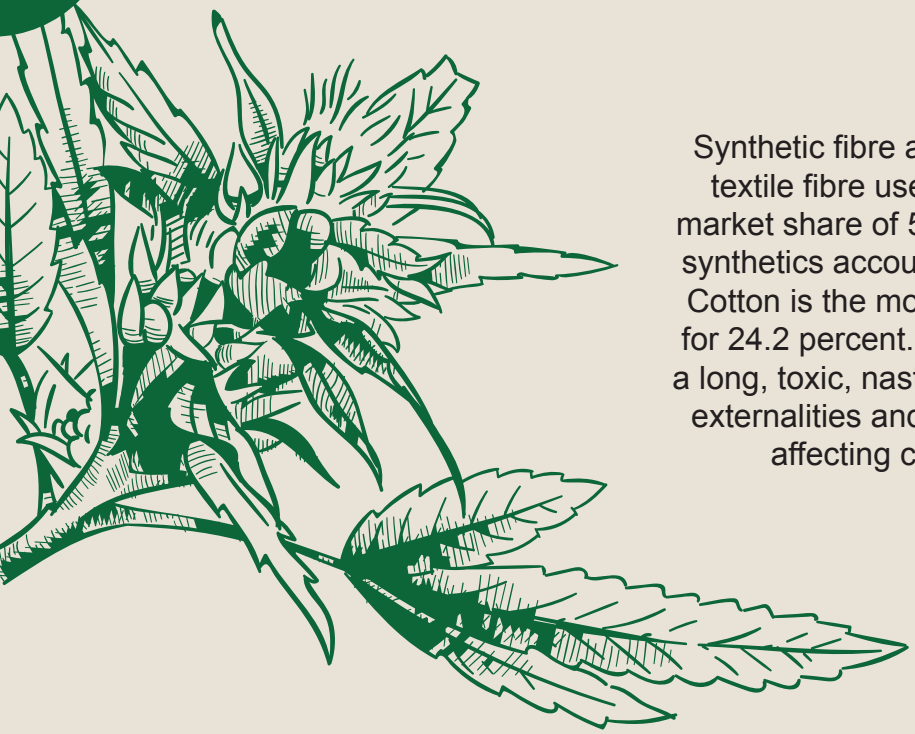
Actors in the Industrial hemp value chain. Industrial hemp is produced for three main products: CBD, Seed, and fibre. This gives it some unique value chain actors different from other fibre producing crops. Seed Suppliers. **Seed suppliers** are fundamental and often approved after meeting international standards and adhering to country regulations. Seeds are sold directly to industrial hemp producers. All categories (small, medium, and large-scale producers) exist in European, American, and Asian hemp-producing countries. In Africa, however, only small-medium scale producers are common, primarily due to the controlled cultivation system. **Producers.** Industrial hemp growers complete the operations from planting to harvesting. As the industry evolves, growers choose methods of operations: manual or mechanically, determined mainly by finances and business objectives. When producers are under contract to deliver dried biomass material or those who sell on the open market, they often find the need to invest in a drying solution. Larger scale drying and storage facilities are developing as producers connect with experienced companies offering more capital-intensive drying solutions.

In Africa, growers experimenting with small acreages will want to develop confidence and obtain certifications in drying capabilities before scaling plots to meet expanded contract opportunities. Equipment manufacturers and producers continue to innovate to improve the harvest process. ***Processors and Extractors.*** Hemp floral and leaf biomass processing for cannabinoid extraction is typically done on a small scale by vertically integrated medicinal herb companies selling their own branded products. ***Marketers***. These actors are complete when they supply to the end-user – consumers. Marketers comprise wholesalers and retailers. Retailers and wholesalers are often involved in the sell industrial hemp and CBD products. In advanced producing countries, the retail landscape for hemp extract products has developed rapidly online and at small shops in strip malls.

Given the lack of official data, a lack of time series data on price movements, and only experimental-scale cultivation cost and yield data, developing a view on the feasibility of industrial hemp is fraught with difficulties. Evidence shows that industrial hemp production is limited, demand is thin, and the volumes traded are low. Therefore, our analysis of commercial viability and investment decisions in the value chain is based on projections and perceptions of likely market development rather than existing market opportunities. Furthermore, studies show that the proposition of industrial hemp as a crop with enormous opportunities for growth falls into three groups.

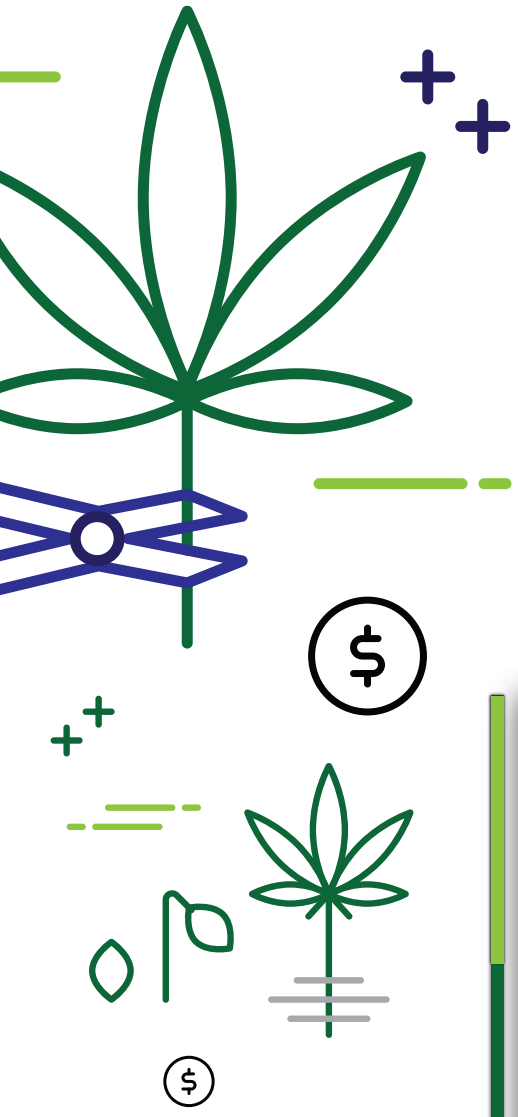
Nigeria's Fibre Industry and Policy: Cotton is the most important fibre crop in Nigeria. It is the country's most extensive fibre crop - per volume of output produced. Cotton development started in Nigeria in 1903 and can be grown in 24 States across four agroecological zones. Its fibre is the primary cost driver in the Nigerian Textile Industry, contributing 69 percent to spinning, 75 percent to weaving, and 57 percent to dyeing, printing, and finishing. Cotton has diverse uses, and the main products supplied from the Cotton VC in Nigeria include - Cotton lint which is the primary driver of the flow in the cotton market; ***Cottonseed***. The cottonseed market consists of the processors that transform it into raw oil and cake. The major drivers for the Cottonseed market are demand in food processing and other industrial processes, growing awareness about the health benefits, and low prices of cottonseed oil.

Over 95 percent of cotton lint used in Southern factories is supplied from the north. Zamfara state used to have 17 cotton processing industries, the highest in the country. However, only 4 of these industries are operational and operating at 10 percent capacity. According to Institute for Agricultural Research (IAR), the contribution of Cotton to Nigeria's gross domestic product (GDP) has dropped from 25 percent to 0.4 percent in the last two decades. Cotton output growth in the country has been rather erratic. The supply uncertainty created by this situation affects industrial off-takers, especially the textile industry with many subsectors that depend on it.



Synthetic fibre accounts for almost 62 percent of the textile fibre used in Nigeria. Polyester alone has a market share of 52 percent, while polyamide and other synthetics account for 5 and 5.2 percent, respectively. Cotton is the most important natural fibre, accounting for 24.2 percent. Changing petroleum into polyester is a long, toxic, nasty process that leads to environmental externalities and causes debilitating health problems affecting consumers and factory workers.

Shrinking local markets and low seeds available to farmers have inspired Nigeria's cotton farmers to shift to other crops, resulting in the fast slide towards extinction, as shown in Figure 11. During the consultations, about 70 percent of the Cotton farmers in the north express willingness to allocate one- third of their Cotton farms to Industrial hemp production and Kenaf. Likewise, farmers in the south who cultivate relatively smaller areas indicate intent to convert 100 percent from Cotton to Industrial hemp and other sustainable fibre crops. However, the switching is conditioned on some factors, including the ***availability of forward contracting arrangements*** with clear and transparent terms, plans for continuous ***sensitization and capacity building on good agronomic practices***, and timely ***access to quality inputs*** at affordable prices.



Evidence from our consultation in Nigeria shows that the production of novel fibre crops, such as industrial hemp and Kenaf, centered around a limited number of processing plants or contracting companies. This is because many specialty or novel crops often have no cash or "spot" market and are only grown by growers who have formal or informal contracts with processing companies. Also, studies indicate that cultivating a novel crop without a contracted buyer can be financially risky if no established alternative cash market exists. Producers selling their commodity into a thin market can be disadvantaged by a lack of price transparency for decision-making and risk reduction and a lack of alternative buyers.

Potential for establishing an industrial hemp value chain in Nigeria. Nigeria has capacity and capabilities in almost all activities related to potential industrial hemp end uses. Some of the potentials for developing an industrial hemp value chain in Nigeria, at the upstream value addition and downstream capabilities and areas that require further support and upgrade are:

Suitable for Production in Most of Nigeria's agroecology. Researchers at IAR&T confirmed that industrial hemp was successfully germinated and cultivated to harvest using limited inputs and rain-fed growing techniques during on-farm trials using certified imported seeds.

Higher Profit Margin: Depending on the end-use chosen, the margins per acre possible with this alternative rotational crop suggest that diversification into industrial hemp would be commercially viable for smallholders. This is particularly true in light of the likely pressure on cotton prices caused by decreases in demand.

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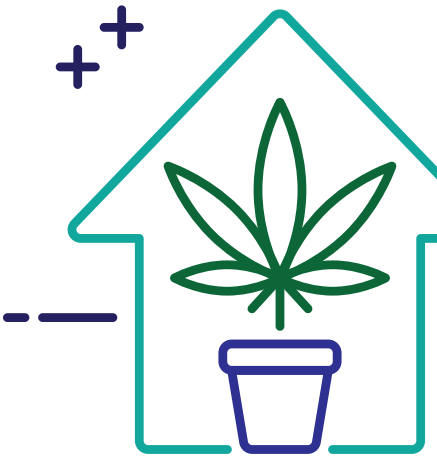
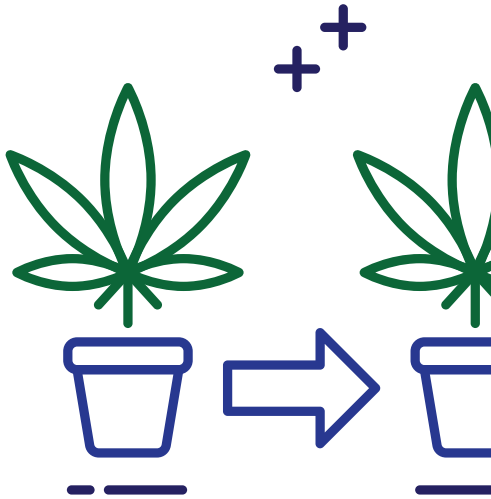
Lower Environmental Impact: The credentials of industrial hemp interms of required inputs and effects on soil suggest that, environmentally, the crop would be superior to cotton. However, given the structure and history of smallholder agriculture in Nigeria, a shift to industrial hemp as an agricultural commodity would need to occur within a system of value chain upgrading and support, as well as contract buying or offtake agreements.

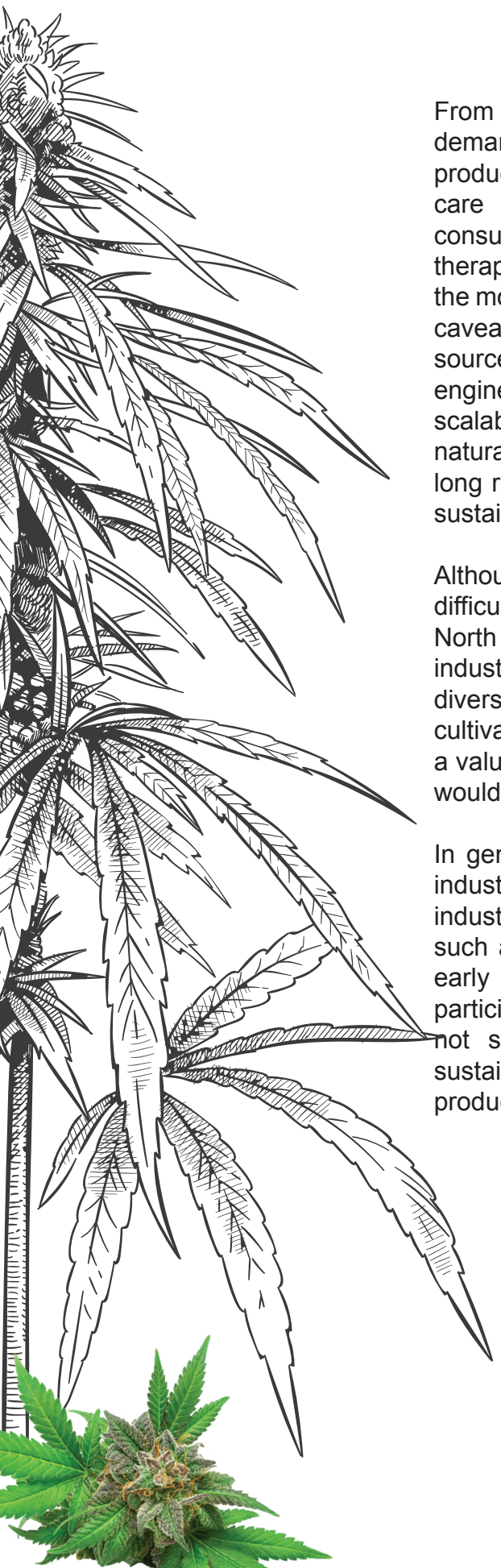
Processing Capacity and Technology. Downstream processing capability and capacity in Nigeria would vary across different uses of industrial hemp. Fortunately, capacity and capabilities are highest in the current niche markets of CBD oil extraction and seed production, which exhibit the highest levels of demand and are viewed as having the most significant potential to grow. Private investors and the FG are not starting from scratch even though they will be significantly upgraded, especially for valuable end-use products. Due to a decline in the demand for cotton, several moribund processing facilities such as cotton seed oil plants have been converted and upgraded to produce other vegetable oils. There is no reason not to assume that a similar process could be undertaken for industrial hemp.

Existence of Farmer Input Support Programmes that aids Diversification. Anchor Borrower Programme (ABP) is a support programme introduced by the FG and made available for different crops to facilitate cash crop diversification. These policies and programmes bode well for potential diversification into industrial hemp, as there is, in principle, a tried and tested mechanism to support a shift into alternative crops.

Willingness to Switch from Cotton to Alternative Fibre Crops. During our consultations for this study, almost 70 percent of cotton farmers express the desire to allocate one-third of their cotton farms to alternative fibre crops such as industrial hemp production. Producers' willingness to switch is based on the availability of offtake contract arrangements and capacity building on good agronomic practices.







From the review, we find that the most viable and most robust demand-led niche markets for industrial hemp are currently: the production of hemp oils to be used in cosmetics and personal care products, the production of hemp seeds for human consumption as a 'super food', and the production of CBD oil for therapeutic use. Of these three, CBD oil production is likely to be the most lucrative in the short term. Although there is an essential caveat that if CBD oil demand increases substantially, naturally sourced compounds are likely to be overtaken by synthetic, engineered equivalents that are cheaper to produce and more scalable. This suggests that the CBD market sourced from natural plant materials may not be sustainable in the medium to long run. However, the market for hemp as a foodstuff remains sustainable, as does the market for essential oils.

Although due to an absence of data, a more extensive analysis is difficult. Nevertheless, preliminary findings from case studies in North America, Europe, Asia, and Southern Africa indicate that industrial hemp would be a profitable and potentially strategic diversification. If and when the legislative constraints on cultivation are lifted, challenges will remain in implementing such a value chain. However, no challenges have been identified that would not, in principle, be solvable.

In general, we find that there is an undeniable opportunity for industrial hemp to become a niche product and for a future industrial hemp value chain in Nigeria to be based on servicing such a niche market. If global demand subsequently expands, early adoption and entry into the value chain will position participants in an advantageous position. Even if the market is not scaled up, the niche market opportunities will remain sustainable as a source of cash crop diversification and new product range manufacturing opportunities in the country.

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Introduction

Background Information and Context of the Study

Nigeria is endowed with a variety of agricultural resources that, if properly harnessed, can serve as a stimulus to the processing industries and a booster to the country's economic growth. The value addition strategy on agricultural produce provides ample opportunity for revenue generation, job creation, reduction of poverty, raising the GDP, and addressing the trade imbalance. The processing of Agro raw materials into various innovative products promotes market acceptability. It generates high product economic value, bringing higher income for value chain (VC) actors and enhancing national economic growth and development. VC presents a business dimension to the production of any commodity and ensures that production is linked to the demand and the critical role of organizing the flow from producers (farmers) to consumer opportunities. However, value subtraction comes to the fore when the end price does not compensate for the investment cost.

The challenges that have accompanied the Cotton industry in Nigeria in the past decades have sufficiently inhibited economic growth in the fabric and associate sectors and diminished supply chain actors' income. Thus, presenting a diversification opportunity for close substitutes, including Industrial Hemp, due to their yield potential and the minimal impact they tend to have on the environment. But persuading farmers to substitute Kenaf and industrial hemp on acreage traditionally planted in crops like Cotton has not been easy due to the lack of enterprise budget data, traditional beliefs, rigid government policy, and lack of political will. However, the desirable features are yet to be explored, hence the need for this project.

The Powering Economic Growth in Northern Nigeria program, which is aimed at diversifying the economy of the Northern region of Nigeria and supporting the socioeconomic development of the various states in the region through collaboration with international stakeholders and donors, has identified the need to foster national development in agriculture through the application of climate-smart techniques that will impact positively on the Northern region along the three main dimensions of sustainable development: economic, social and environmental, i.e., sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and removing greenhouse gas emissions. It is an approach for developing agricultural strategies to secure sustainable crop security under climate change. This aims to ensure enormous economic benefits without negatively affecting the welfare of the people and their habitable environment. Bearing this in mind, this project has been propagated and envisioned by the donors' willingness to transform strategic VCs to improve resilience and reduce climate impact through several approaches, including developing sustainable fabric alternatives to Cotton.

Sustainable Fibre alternatives to Cotton: Growing Cotton is degenerative to the environment because conventional Cotton is a heavy feeder, requiring a massive supply of water, mineral fertilizers, and pesticides, thus, harming the planet. The global appeal of Cotton has made it increasingly difficult for farmers to shift into sustainable fabric production alternatives irrespective of the climatic implication of its production. It is assertive to mention that the imminent ban on exporting agricultural commodities in plastic bags will continue to ensure the rise in Cotton production in Nigeria, notwithstanding the damming consequences on the environment. This ban is expected to stimulate demand for Cotton-based sacks, which is expected to trigger Cotton production across Northern Nigeria. Considering climate change's effect on agriculture in Northern Nigeria, additional degenerative production practices will exacerbate the downward spiral and harm the environment even more. However, Kenaf and industrial hemp have been suggested as fibre alternatives in Northern Nigeria to alleviate this constraint while ensuring adequate economic benefits.

Industrial hemp and Kenaf have been produced and used as major sources of fibres, paper, and other materials for many years. These fibre crops do not require fertilizers or other agrochemical inputs. They require much less water than Cotton during their production cycle (Hemp uses 50 percent less water per season than Cotton, a hectare of Hemp uses 9,000 litres less water than a hectare of Cotton). Thus, they are outstanding candidates for the reclamation of degraded lands. More, it has been revealed that one hectare of industrial hemp can absorb 15 tonnes of CO2 per hectare, similar to Kenaf, making it one of the fastest CO2-to-biomass conversion tools available.

However, realizing the potential of alternative fibres in countries including Nigeria has not been easy. While there is vast potential for using these products for the reclamation of degraded lands and developing industrial products, further research is needed. For instance, which crops offer the best alternatives and which varieties are grown in which conditions? There is also a need to investigate the effectiveness of other aspects of the VC, like aggregation and processing. Work needs to be done around governmental advocacy (particularly industrial hemp), which has already been subject to certain national restrictions.

Research Questions for the Industrial Hemp VC Study

The project will address the following questions:

- What are the market development potentials and commercial viability of industrial Hemp VCs?
- What are the possibilities of substituting or combining Cotton with Hemp as gaps in the VCs that provide investment opportunities?
- Are the industrial Hemp VCs socially sustainable?
- Are the industrial Hemp VCs environmentally sustainable?

Objectives of the Industrial Hemp VC Study

The broad objective of the project is to assess how cotton can be substituted with industrial hemp in Nigeria to meet local and international market demands for national growth and development. The objective will be met by meeting the following specific objectives:

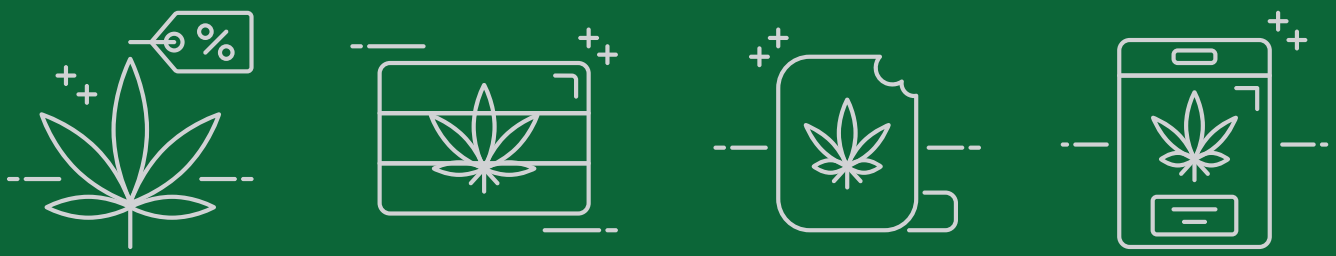
- Assess the market development potentials and commercial viability of Hemp VCs as well as document the growth inclusiveness.
- Examine the possibilities of substituting or combining Cotton with hemp and identify and document gaps in the VCs that provide investment opportunities.
- Determine the social sustainability of the industrial hemp VCs.
- Assess the environmental sustainability of industrial hemp VCs.

Rationale for the Industrial Hemp VC Study

The agricultural development initiatives of the past were hinged on production output without adequate consideration of the market and livelihood drivers that holistically promote national and inclusive economic growth. In addition, Nigeria's agricultural development interventions have neglected the relative importance of developing sustainable commodity supply chains within the context of social and environmental impacts, thereby negating the sustainability approach of the entire process. It is important to note that, for any commodity VC to be sustainable, its economic, social, and environmental components must be effectively exhausted for mutual and inclusive benefits.

The VC is pivotal to agricultural development due to its trans-sectorial capacity to add economic value and create employment inclusively and sustainably. It represents an operational framework within the agri- food sector and engages farmers and businesses. VC analysis can help in decision-making by assessing appropriate indicators, setting up baselines, and providing information on the changing situation of the actors related to the intervention.

Industrial hemp possesses enormous potential. The development of these VCs will provide significant economic benefits to the VC actors by encouraging the balance of trade, and trade relations, improving the national Gross Domestic Product, and enhancing the quality of life of people in the country.



Methodology and Scope of Work

Study Locations and Data Sources

The fieldwork was conducted in eleven (11) states to collect data on Industrial Hemp (IH), Kenaf, and Cotton from stakeholders in the value chains. The initial ten (10) states identified for the study included: the focal states Kano, Kaduna, Jigawa, and other seven states: Katsina, Zamfara, Oyo, Ogun, Kwara, Benue, and Kogi. Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted in each state. It is important to note that FGDs and KIIs were undertaken concurrently with Industrial hemp and Cotton VC actors – Producers, Traders, and Processors. It is important to highlight that in this report, we focus specifically on Industrial hemp and some activities in the cotton value chain. There was tremendous difficulty in acquiring information on industrial hemp in these states. Although we eventually secured unstructured, informal interviews with some industrial hemp actors in Ondo state through a contact at the state AFAN office.

Accounts from industrial hemp key informants indicate that the Ondo state government has been advocating for the legalization of the industrial hemp crop and developing the entire VC in the state. We conducted FDGs with two groups of four informants at different times; they insisted that their participation remain anonymous for fear of arrest, considering that industrial hemp production, processing, and marketing are still illegal in Nigeria. KII session was equally conducted in Ondo state with a state AFAN official who prefers to be anonymous. The informant grew up in the areas of the state where industrial hemp was cultivated and had insight into the workings of the Industrial Hemp business.

We assured respondents of a high level of confidentiality and cleaned and synthesized the data following international best practices. The data were analysed and interpreted using modern software and presented in a suitable format. We adopted mixed methods in undertaking the study. Data and evidence collection involved the use of various tools and resources, including the following:

Desk Review. Desk study involves literature review, reports, relevant documents, and online databases. Also reviewed are publications and reports (see references). The desk review entails an analysis of market reports, policy documents, technical reports, journals, newspaper articles, and other relevant documents. The review helps identify the stakeholders, market dynamics, prospects, challenges, solutions, and entry points for Industrial Hemp in Nigeria. Moreso, the task involved a thorough assessment of the local, regional, and global VCs of Industrial Hemp and other fibre crops. Additional information was collected from relevant government ministries, departments, and agencies (MDAs), including research and development institutes, and academic institutions.

Key Informant Interviews and Focus Group Discussions. Interviews with key actors at all stages in the fibre crops value chain, including experts and resource persons, on themes related to the study's specific components, including functional, economic, social, and environmental issues. The interviews were either semi-structured or unstructured and centred around key issues in the value chain. In identifying stakeholders, we considered factors such as category, role, and influence in the Industrial Hemp VC and their relevance to the study. We designed a participatory framework for stakeholder engagement during the KIIs and FGDs. The FGDs were conducted with primary industry association stakeholders - farmers, processors, and aggregators. The KII activity was undertaken with MDAs and the top representatives of national, regional, and global industry associations, resulting in a robust VC data analysis for Industrial Hemp.

Furthermore, we conducted the surveys with the mapped stakeholders at the agreed time and venue. We used probing methods to record our pre-designed data entry templates and expert interviewers. Notetakers were engaged to take notes and provide the research team with an accurate and full account of the information conveyed (responses and observations) in interview sessions. Also, we will provide modalities for virtual interviews and adhere to the COVID-19 prevention guidelines for physical KIIs and FGDs by using face masks and hand sanitizers where required.

Participants in the study were interviewed using structured checklists that were pre-tested. The purpose of pre-testing was to identify problems with the data collection instrument and find possible solutions. Our approach has allowed appropriate adjustments before full-scale administration of the instrument, helping to ensure that standardized procedures are applied during data collection.

We adopted a mix of analytical tools, including the following:

- Basic statistical analysis to underpin the functional analysis;
- Basic accounting framework for the financial analysis of the operations of key actors;
- Basic excel spreadsheets were used for the economic and marketing analysis, including computing the total value added in the chain;

Stakeholders consulted and analytical scope of the study

The fieldwork occurred from February to April 2022. Overall, the exercise was fruitful and enabled the team to obtain essential data relevant to the study. However, due to the absence of an industrial hemp value chain in the country, we filled gaps through desk reviews using open-source documents, virtual meetings, and emails with industrial hemp key informants. At the beginning of the study, we had a briefing session with FCDO-LINKS officials in Kano. The discussion was quite insightful and thoughtfully guided the fieldwork. Other stakeholders consulted included those below (also see Appendix 1 for the complete list of stakeholders consulted):

- **Government:** FMARD, Abuja; ADPs (Kano, Katsina, Kogi, Benue, Jigawa, Kwara, Kaduna, Zamfara); the National Agricultural Seed Council (NASC); Institute of Agriculture Research (IAR), Zaria; Institute of Agriculture Research and Training (IAR&T), Ibadan; Forest Research Institute of Nigeria (FRIN), Ibadan; National Drug Law Enforcement Agency (NDLEA); National Environmental Standard and Regulation Enforcement Agency (NESREA); State Ministry of Environment (Kano, Jigawa, Kaduna, Katsina, Kogi); State Ministry of Health (Kano, Kaduna, Jigawa, Katsina)

- **Education Institutions:** Federal College of Agricultural Produce Technology, Kano; Centre for Dryland Agriculture, Bayero University, Kano.

- **NGOs/Representative Organisations:** All Farmers Association of Nigeria (AFAN); Kenaf Producers, Processors and Marketers of Nigeria (KEPPMAN); Kenaf Development Association of Nigeria (KEDAN); Cotton Producers and Merchants Association of Nigeria (COPMAN); Zamfara Accelerated Cotton Development Agency (ZAMDACOD); National Cotton Association of Nigeria (NACOTAN).

- **Private Companies:** Arewa Textiles, West African Cotton Company (WACOT), Dala Ginnery, Zamtex Limited.

- **Others:** Nigeria Incentive-based Risk Sharing Agricultural Lending (NIRSAL); Kano-Office of the International Institute of Tropical Agriculture (IITA).

LINKS
Catalysing Economic Growth for Northern Nigeria

The VC study is national in scope. Still, we focused on the three target states – Kano, Kaduna, and Jigawa – and eight top fibre-producing states, covering three major agroecological zones. The Federal Capital Territory, Abuja (FCT), is of interest because it hosts relevant policymaking institutions. At the same time, additional information is sourced from models across Africa and other developed markets in Europe and America for Industrial Hemp.

Industrial hemp was first domestically cultivated in Mesopotamia in 8000 BCE. China began cultivation in around 4000 BCE, and from about 1000 BCE to the 19th century, it was the world's largest agricultural crop. From the 16th to the 19th century, industrial hemp was universally used for ship sails and rope. It was crucial in supporting the global expansion of shipping, trade, colonization, and military activity (Young 2005). By the 20th century, steam-powered and petroleum-fuelled engines eroded the largest demand for industrial hemp (shipping), and the development of the cotton gin made cotton more commercially viable than industrial hemp as a fabric for clothing. Industrial hemp cultivation, therefore, began to decline.

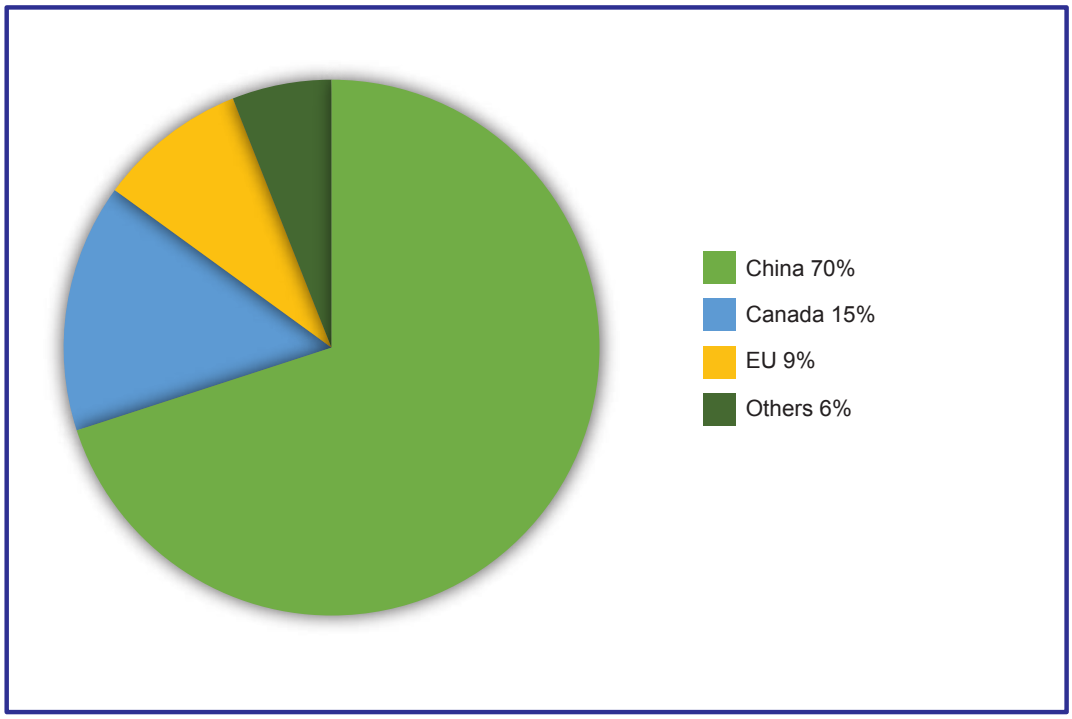
In the inter-and post-war years, the outlawing of narcotic marijuana gained momentum internationally. Unfortunately, industrial hemp is the strait-laced, non-narcotic cousin of marijuana, but because the two plants look similar, industrial hemp was tarnished by association. This erroneous conflation of industrial hemp and marijuana led to the prohibition of industrial hemp cultivation in most countries from the 1950s onwards. Industrial hemp disappeared globally as an agricultural crop in the second half of the 20th century. This disappearance affects the plant's current commercial opportunities and downstream products. No research and development or technology development related to the crop or its processing has occurred in seven decades.

Production of industrial hemp

Leading global producers of industrial hemp

The key players in the industrial hemp value chain are the US, Canada, China, and the EU. No official data exist on current production volumes, crop differentiation (fibre or seed), or trade-in differentiated industrial hemp products. Still, most sources agree that China is the dominant global supplier of industrial hemp, producing roughly 70 percent of global output. However, as has been said, its production is currently focused exclusively on fibre production. Canada is the second-largest producer at roughly 15 percent of the global market; however, it produces only seeds for human consumption. EU countries account for most of the remaining share of global production, France being the single largest EU producer at around 9 percent of the global output. France produces industrial hemp almost exclusively for the paper industry, specifically paper used in cigarette production.

FIGURE 1: PERCENTAGE SHARE OF GLOBAL OUTPUT OF INDUSTRIAL HEMP



Source: Indexmundi.com (2021)

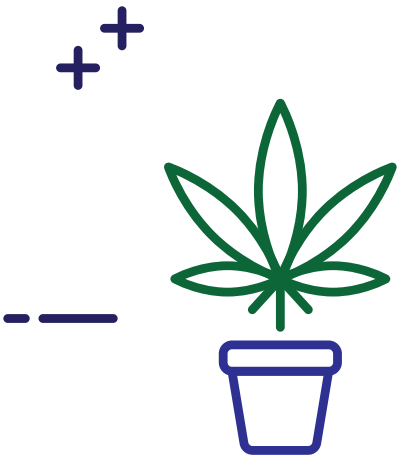
As shown in Table 1, more than 30 countries and at least 47 US states have enacted legislation to establish hemp production programs or allow for hemp cultivation. In all these locations, industrial hemp cultivation is subject to a minimum level of THC content, which allows industrial hemp to be differentiated from its narcotic cousin, marijuana. In all these countries, industrial hemp is regulated, even if it is legally permitted.

TABLE 1: COUTRRIES WITH ENACTED LEGISLATION TO ESTABLISH HEMP PRODUCTION PROGRAMS, 2020

Africa	Europe		Asia	America	Others
Lesotho	Austria	Italy	China	US	Australia
South Africa	Denmark	Netherlands	India	Canada	New Zealand
Ghana	Finland	Poland	Japan		Chile
Egypt	Germany	Sweden	South Korea		
Zimbabwe	Greece	Ukraine	Thailand		
Uganda	Hungary	Switzerland	Turkey		
Zambia	UK	Slovenia			
Rwanda	Romania	Portugal			
Malawi	Spain				

Source: Cherney and Small (2016)

An important point to note is that industrial hemp cultivation remains a minor and insignificant crop globally and in national agricultural statistics. To provide some scale of the industry at present, in 2018, it was estimated that 79,000 acres of industrial hemp was grown across the US. This compares with 47 million acres of wheat and 90 million acres of corn in the same period. Even China's 200,000 acres of production and Canada's 225,000 acres of production do not constitute 1 percent of agricultural crop output. This reinforces the demand issue raised earlier: that the commercial opportunities of industrial hemp are based on potential demand scenarios rather than current supply or demand. A second important point to note is that the industrial hemp market (even from the supply side) cannot be seen as a homogeneous market, as the plant is cultivated for fundamentally different end uses. As will be shown when looking at cultivation techniques and profitability in the following section, what an industrial hemp crop is used for has a fundamental bearing on the commercial feasibility of the crop.



Agroecology of industrial hemp production

Industrial hemp originates from central Asia and can grow in several agroecology. Multiple landrace strains exist in almost all climates and soil conditions, making industrial hemp an extraordinarily flexible and unfussy plant to cultivate. The plant is easily hybridised, and cultivars and varieties can be bred to support specific plant characteristics within seven generations. The plant is a fast grower; it naturally suppresses weeds and hence largely eliminates the need to use expensive herbicides. The plant also improves soil health—especially aeration. The plant's ability to improve the quality of the soil plus its rapid growth make it a perfect rotational crop, and it has been found that food crops can be grown on a plot used for industrial hemp immediately after the hemp harvest with no fallow period required.

A. On-farm conditions – agronomy

Seeds Required. Industrial hemp is grown by seed, with virtually every regulatory body responsible for licensing insisting on the use of certified seeds bought annually. This ensures that low THC content and plant characteristics are maintained over time. Seeds are developed through breeding programmes to achieve the specific characteristics needed for the dominant use of the plant.

Planting Requirements. Seeds are usually planted between September and November in the Southern hemisphere on beds that have been prepared like other row crops. Planting density differs fundamentally depending on the end use of the plant and the variety. Different densities impact the diameter of the stem, the fibre length, fibre content, fibre yield, number and density of branches, and hence the size of seed heads and quantity of seeds and oil content. Essentially, closely planted crops will produce long, tall plants with few side branches, which are preferred for fibre production. Plants cultivated for seeds will be planted less densely so that more side branches develop, as this is where flowers and hence seeds are produced.

Consequently, plants cultivated for seed and oil will be shorter and squatter, with a fuller vegetative pattern. Amaducci et al. (2015) recommend a density of 150–200 plants per square metre when growing for fibre. For non-textile fibre, it is recommended that plants be sown at a density of 250– 350/m2, for paper and pulp 90/m2, for essential oil 15/m2, and CBD oil 10/m2. These vastly different densities suggest that scales of farming, yields, and commercial feasibility will differ according to the end use of the crop.

Soil Condition. Soil with a pH of 6 to 7.5 is recommended, and the soil should offer good water-retention properties, sandy loam and clay loam being the two preferred soil types. Fertilizer required. If the crop is to be grown for commercial purposes, it is suggested that potassium, nitrogen, and phosphorus be added to the soil before the seeds are planted. However, this is contested by some agronomists, who argue that additional nutrients are not required. Water required. Germination occurs within three to five days of planting, and it is recommended that at this stage if there is no rain-fall, the crop be watered at a rate of 3ML to 6ML per hectare. Temperature required. Optimum growth temperatures are 15–27 degrees Celsius. The crop will grow rapidly for three to four months, creating branches and leaves in its vegetative phase of growth before forming seed heads as the length of the day begins to decrease. Industrial hemp plants also respond differently to different input conditions. For example, higher temperatures and lower rainfall will accelerate flower development and seed production but will delay vegetative plant growth and fibre maturation. Fertilizers have been found to improve yields when hemp is grown for seed but not when it is grown for fibre.

B. Off-farm conditions – harvesting and end-uses

Hemp is a multi-use, multi-functional crop that provides raw materials for many traditional and innovative industrial applications. For each end-use destination, there are specific characteristics and quality requirements for the properties of the bast fibres, the oil, the protein in the seeds, and the profile of secondary metabolites such as CBD. Linked to this are different starting seed cultivars, different agro- techniques, and differing plant density and input requirements. The heterogeneous nature of the plant and its crop suggests that, when entering the industrial hemp cultivation market, understanding the end use of the hemp input will be crucial in decision-making from seed selection onwards. There is substantial disagreement over whether industrial hemp is more commercially viable as a dual-purpose crop than a single-end-use crop, merely adding to already complex cultivation and usage decision.

1 **Harvesting Requirements for fibre end-use.** End use is also crucial in determining when the plant is harvested. Amaducci et al. (2015) note that, when grown for bast fibres, the crop should optimally be harvested at the full flowering of the male plant. A delayed harvest will increase biomass and stem production yield, but simultaneously decrease the yield of bast fibres. Postponing harvesting until seed maturity (which maximizes seed yield) will result in a lower proportion of bast fibres and a higher proportion of hurd. The method of harvesting is similarly determined by the envisaged end use of the plant. When grown for fibre, the whole plant needs to be harvested. This is traditionally done by hand in developing countries—mainly because industrial hemp plant stalks are thicker and stickier than the types of stalks modern combine harvesters are designed to harvest. It is technically feasible to bring in an industrial hemp crop using a combined harvester designed for wheat or corn. Still, the cutting and mowing mechanisms will regularly get stuck and clogged up, and machinery parts will wear out rapidly, negatively impacting the equipment's efficacy. Because there has been no commercial-scale cultivation of industrial hemp for over five decades, purpose-built industrial hemp machinery has not been developed. However, German and Canadian companies are looking at customizing existing combine harvesting equipment for the industry. Therefore, there is currently an advantage to manual harvesting.

Retting. Once the stalks have been cut, a process called retting is required when harvesting for fibre. This decomposition process separates the usable bast fibres from the woody hurds. Retting can be done in three ways. (1) Paddock or dew retting is when the stalks are left in piles on the ground in the field where they were harvested. Decomposition and fungal organisms complete the process of separating the fibres from the hurd over several weeks. If ponds, ditches, or purpose-built tanks are available, (2) water retting can be carried out instead. In this process, fibers are decomposed and separated while the stalks are underwater. Water retting takes less time than paddock retting but is more labour intensive. (3) Enzyme retting. For this option, suitably sized tanks are built and filled with water and an enzyme added to degrade the plant's cell walls. This is the fastest method of retting but also the method that requires the most expensive inputs (enzymes) and the most significant investment in infrastructure (water tanks).

Bailing. Once retting is complete, the stalks are dried until they have only 10–15 percent moisture content, at which point they are baled and transported for processing. The next step is separating the bast fibres from the hurd. This process is known as decortication, and the output is fibres ready to be sent to the equivalent of a cotton gin. As with harvesting, there has been little capital development, except in China.

2 **Harvesting Requirements for seed end-use.** If the plant is being grown for seed or oil, harvesting is something of an art. Seeds are formed in the flower heads. Seed maturation starts at the bottom of the flower and moves upwards so that a flower will have mature seeds at the bottom while still having green seeds at the top. Once the seed is mature, the nut comes loose from its shell and falls to the ground (a phenomenon known as shattering); thus, the useful part of the seed is lost in terms of yield. Therefore, deciding when to harvest is crucial for seeds. The optimal window for seed harvest is when 70 percent of the seed is ripe, and seed moisture is at 20–30 percent. Delaying harvesting may increase yield, but the quality will decrease as the seeds dry out further. Harvesting for seed and oil requires harvesting only the flowers, not the whole plant. Hand-picking is labor-intensive and is the best option to ensure quality and reduce seed damage. Alternatively, harvesting can be done using combined harvesters set to cut off only the top of the plant. Because there is less fibre volume, a lower stalk diameter, and less 'stickiness', traditional combine harvesters do not break down as often as when used for whole-plant harvesting.

Only hand-harvesting works when hemp is grown for CBD oil. This is because the flower heads need to be maintained intact so that the resin-rich trichomes are not dislodged. High-quality CBD oil and distillates are produced using only flower heads, while lower-quality CBD oils contain some stalk and leaf material. When harvested for CBD oil, the flower heads (or more significant portions of the plant, including stalk and leaves) need to be dried. This is currently done by hanging the plant material upside down in a drying barn or specialized drying chamber. Once the plant is entirely dehydrated (10 to 14 days), it can be transported for further processing.

This shows the complexity—and hence required forethought—of planning for the end use of an industrial hemp crop: end-use decisions must be made before selecting the seed variety, let alone the method of cultivation and input requirements. Opinion seems divided as to whether growing industrial hemp for a single purpose end use (as a mono-crop) is commercially viable or whether it has to be cultivated as a dual-purpose crop (Coogan 2016) to achieve or surpass the commercial return of other row crops. Issues of commercial viability, substitutability, and potential selling prices are assessed below.

TABLE 2: INDUSTRIAL HEMP VARIETIES IN THE UNITED STATES

S/N	Name of Variety	Origin	Quality attributes and uses	Yield range (pounce)
1	Black Jack	Colorado	High yield for oil extraction and flower	2-3 per plant
2	Otto II Boax	Colorado	Non-feminized hybrid tri-crop variety grown for seed, fibre, and CBD extraction	
3	Abacus	Colorado	High yielding for flower	2,500-3,000 per acre
4	Purpose Mesa	Colorado	High yielding for flower	700-800 per acre
5	Scarlet	Colorado	High yielding for flower	800-900 per acre
6	Abigail	Colorado	High yielding for seed, fibre, and CBD extraction	
7	Anna Lee	Colorado	High yield for oil extraction and flower	
8	Athena	Colorado	High yielding for seed, fibre, and CBD extraction	Potential high-yielding variety
9	Indoor Angie	Colorado	High yield for oil extraction and flower	Long bud structure with high-yield potential
10	Berry Blossom	Colorado	High yielding for seed, fibre, and CBD extraction	Average 2,500-3,000 of dry whole plant material per acre
11	Merlot	Colorado	High yield for oil extraction and flower	2,500-3,000 pounds of dry, whole plant material per acre
12	Chardonnay	Colorado	High yielding for seed, fibre, and CBD extraction	2,500-3,000 pounds of dry whole plant material per acre
13	Red Bordeaux	Colorado	High yielding for flower	2,500-3,000 pounds of dry whole plant material per acre (dry whole plant material)
14	Garlic Jam	Colorado	High yielding for flower	1,000 to 4,000 lbs. per acre
15	Autopilot	California	High yielding for flower	1,000 to 4,000 lbs. per acre
16	Guava Jam	California	High yielding for flower	2,000-5,000 pounds per acre, depending on planting density
17	Pipeline	California	High yielding for flower	1,800-4,500 pounds per acre, depending on planting density

18	Maverick	California	High yielding for flower	2,000-5,000 pounds per acre, depending on planting density
19	Lifter	Califonia	High yielding for flower	1-4 pounds
20	Suver Haze	California	F1 hybrid variety grown for flower	1-4 pounds
21	Sour Space Candy	Califonia	F1 hybrid variety grown for flower	1-4 pounds
22	MK4	feral hemp variety x WW2 Time x Master Kush from Hindu Kush Mountains	Full-season variety grown for flower	0.7-1.7 pounds per plant (dependent on location)
23	FL4P	Colorado	Variety grown for flower and fibre	0.2-2.3 pounds per plant
24	CJ2	Colorado	Variety grown for flower and fibre	0.2-2.3 pounds per plant
25	FL58	Colorado	Variety grown for flower and fibre	0.3-2.5 pounds per plant
26	SB1	Colorado	Variety grown for flower and fibre	0.6-2.7 pounds per plant (dependent on location)
26	FL71	Colorado	Variety grown for flower and fibre	0.3-2.3 pounds per plant (dependent on location)
27	Southern Belle	South Colorado	Hybrid variety grown for flower	2.5-4.5 pounds dry weight per plant
28	Southern Luck	South Colorado	Hybrid variety grown for flower	2-5 pounds dry weight per plant
29	Southern Cat Daddy	South Colorado	Hybrid variety grown for flower	2-3 lbs. dry weight per plant
30	Southern OG	South Colorado	Hybrid variety grown for flower	2-5 pounds dry weight per plant

TABLE 3: INDUSTRIAL HEMP VARIETIES IN THE EUROPE

S/N	Name of variety	Climate zone	Main use
1	CS	all	Multiple
2	Carmagnola	all	Multiple
7	Eletta Campana	all	Multiple
3	Codimono	South And Central Europe	Fibre
4	Dacia Secuieni	North And Central Europe	Fibre
5	Dioica 88	North, South And Central Europe	Oil And Flour
6	Earlina 8 FC	North And Central Europe	Oil And Flour
8	Fedora 17	North And Central Europe	Multiple
9	Felina 32	North And Central Europe	CBD flower
10	Fibrol	North And Central Europe	Fibre
11	Fibror 79	North And Central Europe	Fibre
12	Finola	Boreal Continental And Oceanic	Oil And Flour
13	Futura 75	North, South And Central Europe	CBD flor
14	Férimon	North, South And Central Europe	Oil And Flour
15	Gliana	South And Central Europe	Fibre
16	KC Dora	North And Central Europe	Multiple
17	KC Virtus	North, South and Central Europe	CBD flower
18	KC Zuzana	North And Central Europe	multiple
19	Kompolti	North, South and Central Europe	CBD flower
20	Markant	North And Central Europe	fibre
21	Monoica	North And Central Europe	multiple
22	Ratza	North And Central Europe	fibre
23	Santhica 27	North And Central Europe	CBD flower
24	Santhica 70	North And Central Europe	CBD flower
25	Silvana	North And Central Europe	fibre
26	Tiborszallasi	South And Central Europe	fibre
27	Tisza	North, South and Central Europe	CBD flower
28	Uso-31	North Europe Atlantic Zone	oil and flour
29	Zenit	North and Central Europe	multiple

Governance, policy, and regulation of industrial hemp value chain

Although industrial hemp cultivation is legal in 30 countries, fewer than half a dozen dominant producers exist. Development in western markets, where legalization is spreading rapidly, and the prospect of cashing in on the fast-growing multi-billion-dollar sector, contribute to the sweeping reforms on the African continent. At least ten African countries have enacted or are enacting a legal framework for industrial hemp. In 2017, Lesotho became the first country to commercially grant an administrative license to cultivate marijuana for medical and scientific purposes. Since then, several countries have followed suit. Ghana has also authorized cannabis production, but only for varieties with THC (the plant's psychoactive ingredient) levels of 0.3 percent or less.

Malawi and Zimbabwe are major tobacco exporters, and policymakers hope that cannabis can replace the country's top cash crop, given tobacco's destructive environmental footprint. While most countries that allow cultivation also authorize the consumption of cannabis for medical purposes. Uganda and Rwanda are currently growing the plant strictly for exports. In other countries where industrial hemp and cannabis production is still illegal, such as Nigeria, Tanzania, and Kenya, large amounts of the crop are still grown and exported. The economic incentives to legalize the existing trade might mean that these countries' regulations could also change.

The cultivation and supply of industrial hemp and its downstream products are strongly influenced by legislation and regulation. Both are changing rapidly as societal, political, economic, and environmental pressures mount in the light of increased research, changing attitudes, and commercial opportunities. We present a list of leading industrial hemp pressure groups and associations in the appendices.

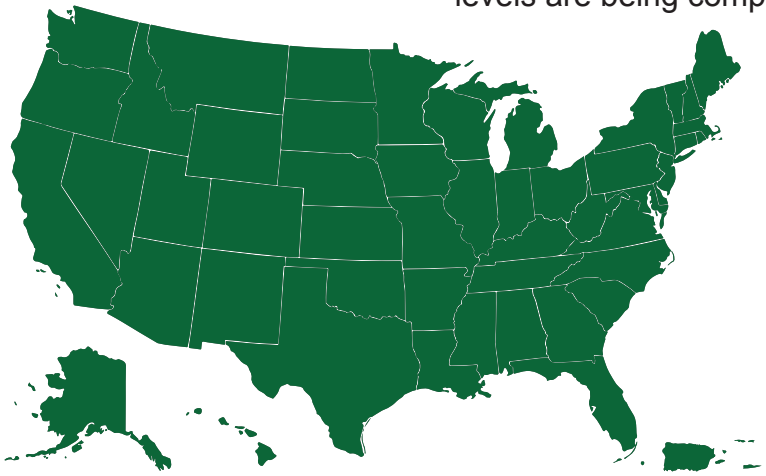
Here, we provide a brief overview of their legislation and regulation to highlight the variation in approach to legalization, regulation, and the use of industrial hemp and its downstream products are described as follows:

United States of America

Agricultural policy in the US is mainly determined by the Farm Bill (Agriculture Improvement Act), which is amended every four to five years. In 2014, on the back of enormous lobbying pressure (particularly from Kentucky tobacco farmers), the Farm Bill legislated to allow farmers to grow hemp in experimental pilot programmes in conjunction with state-run agricultural programmes. The main aim of most of these programmes was to grow industrial hemp to supply the ballooning US domestic market for CBD oil. With the help of state and national crop development scientists, new cultivars were created under the programme. These substantially increased the CBD content of industrial hemp from 2 – 3 percent to 9 – 10 percent.

On this basis, the pilot projects were considered agricultural and commercial successes. Farm Bill of 2018 paved the way for legalizing industrial hemp at the federal level. Under the Bill, industrial hemp is no longer a controlled substance if it has a THC level below 0.3 percent. It is now considered an agricultural product and falls under the control and supervision of the US Department of Agriculture, not the Drug Enforcement Agency (DEA). Cultivars with higher CBD content but THC levels below 0.3 percent have been cleared by the Food and Drug Administration (FDA) and the DEA. However, the FDA still strongly regulates CBD oil sold as a 'wellness' product.

Further changes in the regulations of CBD oil are ongoing. While the decision of the FDA and DEA, and the passing of the 2018 Farm Bill, create a legal environment for the cultivation and distribution of industrial hemp and its associated products, the crop is still strongly regulated. Regulations are developed and enforced at the state level, and in all states where industrial hemp cultivation takes place, licenses are required from the relevant state authority. Licensing requirements differ but, at a minimum, include restrictions on the variety and type of cultivar used, seed certification, and frequent testing to ensure that maximum THC levels are being complied with.



Canada

Industrial hemp cultivation was officially legalized in 1998 in Canada. As in the US, industrial hemp is legal if its THC content is below 0.3 percent. Although the crop is legal, it is strictly monitored and regulated, with licenses granted by Health Canada working in conjunction with the Minister of Health and the Office of Controlled Substances. Because Canada has a legal, medical cannabis industry – and as shown earlier, CBD oil from marijuana plants is viewed as superior to CBD oil from industrial hemp – industrial hemp is grown in Canada as a food crop only. Canada is the largest hemp food producer and exporter globally. They grow industrial hemp for seed and seed only, with no production for fibre or CBD oil. Therefore, most control and crop regulations involve maintaining seed quality and cultivating and harvesting seeds with the best protein, polyunsaturates, and omega oil profiles.

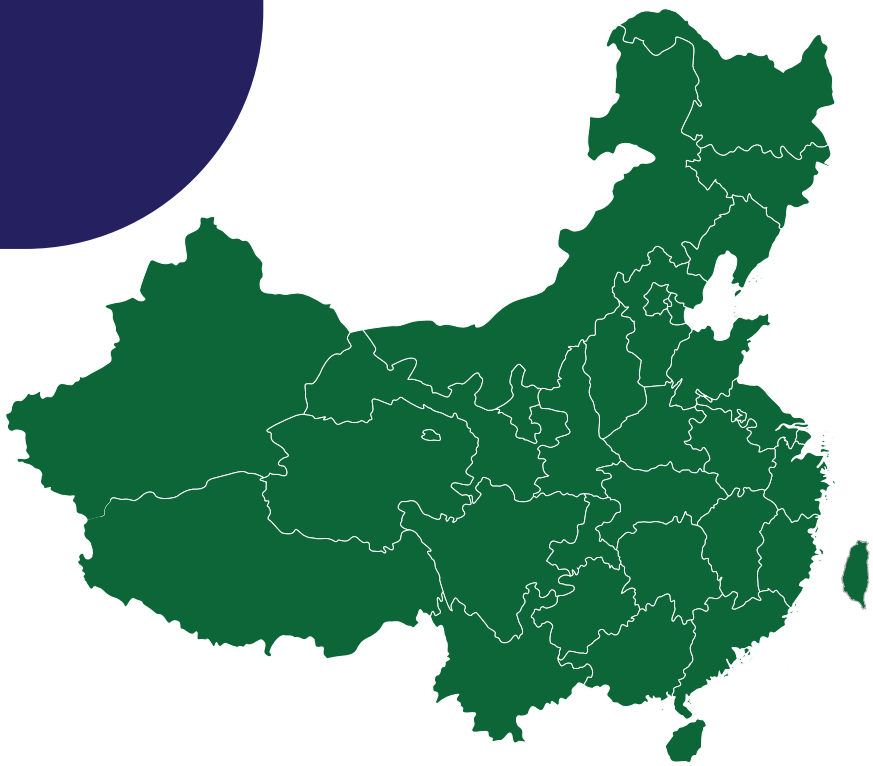
In 2018, over 31,500 hectares were licensed for hemp production. The country's hemp production and export are in hulled hemp seeds, hemp oil, and hemp protein powder. The federal government and producers control hemp varieties and may only plant varieties from the official list of approved cultivars.

Many of the regulations are determined by the Canadian Food Safety Authority rather than the Canadian Agency for Drugs and Technologies in Health. The new Canadian hemp regulations in 2018 indicate that growers can also harvest hemp flowers, leaves, and branches and sell them to licensed cannabis processors to extract cannabidiol (CBD) and other compounds. Although the new hemp regulations are meant to open additional revenue sources and market opportunities, high CBD varieties have yet to be registered for use in Canada.

China

The country is currently the world's largest industrial hemp producer by volume. Industrial hemp cultivation and product production has never been prohibited in China; however, the crop is strongly regulated. The Chinese crop has been developed in support of the fibre industry, and domestic demand for green substitute products, CBD oil, or food or cosmetics products is minimal. The government is allocating additional land for the cultivation of industrial hemp in three provinces and has embarked on an international collaboration project to improve the quality of its seeds and develop different cultivars as it considers changing the end use of its industrial hemp crop given changing global demand patterns.

While China is a major producer of hemp products, it allows hemp to grow in just two regions: Yunnan Province in the south and Heilongjiang Province in the north. Textiles make up about three-quarters of hemp sales. Other products like cosmetics, CBD products, food, and supplements make up the rest. In 2019, the Chinese National Anti-Drug Committee announced the country's stance on industrial hemp farming. The announcement stated that CBD is not included on the list of narcotic drugs in the country and is not a controlled drug. It also stated that cannabis with a THC content of 0.3 percent or less could be grown in certain parts of China. Currently, China permits the sale of hemp seeds, hemp seed oil, and the use of CBD in cosmetics. It has not approved CBD for use in food and medicines.

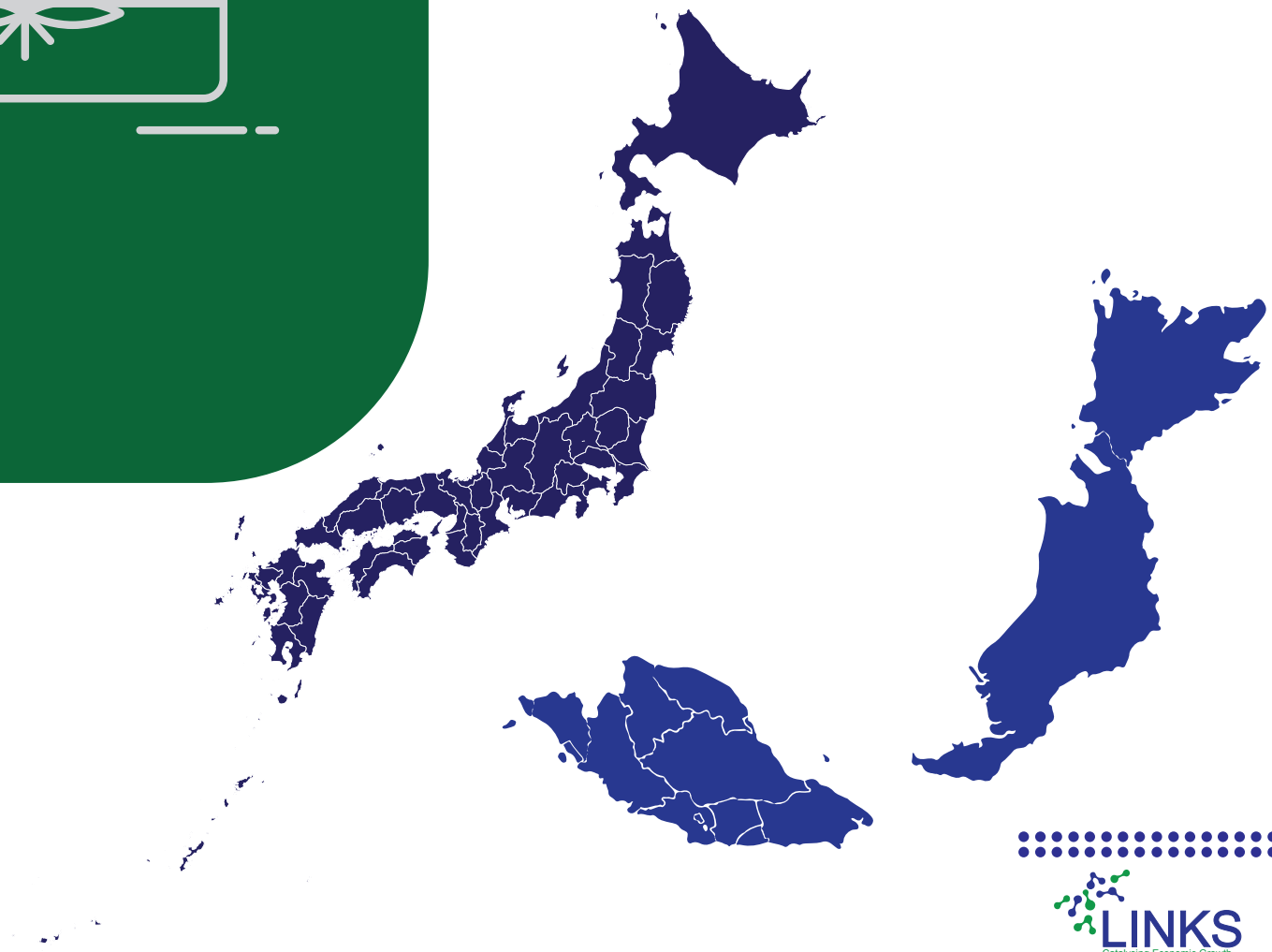


Japan

This is another Asian country that legalised the use and import of CBD products from hemp in 2016. CBD is derived only from permitted hemp farms, and the extraction must be such that no by-product of THC is obtained. The 'Elixinol' brand has been approved for supply and actively promotes its product range in the Japanese market. South Korea. The use of CBD is now legal for medicinal use in South Korea. The country permits the importation of CBD for medicinal use, but prohibits manufacturing cannabis-based drugs. The manufacturing of CBD cosmetic products has also been recently permitted. South Korea's biggest pharmaceutical contract manufacturer, Kolmar Pharma will be the first company to supply CBD to cosmetic manufacturing companies in the country.

Malaysia

In 2019, the Malaysian Government announced that hemp cultivation would be allowed for industrial research purposes, including the production of fibre and seeds.



Europe

Industrial hemp cultivation and supply are legal under EU regulation 1308 of 2013, as long as the plant has THC levels below 0.2 percent. Under EU regulations, the Common Agricultural Policy, industrial hemp qualifies for subsidies. The support programmes for subsidies and research are available as long as specified varieties are used, the seeds are certified, and testing and verification measures are adhered to. In addition to general EU legalization, individual member states can regulate hemp production and cultivation licensing as they see fit. The regulations controlling the use of industrial hemp-derived products differ substantially and are in a state of flux at present. Up until 2016, the UK had no regulations governing CBD oil. In 2016, it was designated a medicine for the first time, and suppliers were suddenly required to obtain 'marketing authorization' or a 'traditional herbal registration' through the Medicines and Healthcare Products Regulatory Agency.

In the European Union, hemp cultivation must come from varieties containing less than 0.2 percent THC. All extracts of hemp and derived products containing cannabinoids are considered "novel", whereas hemp seeds, flour, and seed oil are permitted. According to the EU's Novel Food Regulation, pre-market approval for novel foods is required to enter the EU market. However, within the EU, there is no consistency in which parts of the hemp plant may be cultivated and used. In Germany and Romania, hemp flowers and leaves can be harvested, but in the UK, France, and the Netherlands, only the fibres and seeds can be used. Under its new laws for hemp products in Portugal, industrial hemp farmers must now submit to a licensing procedure as strict as the one for medical cannabis.

CBD regulations are becoming more common across all countries as the general demand for the product increases and authorities seek to protect consumers from unregulated and unsafe supplies. Sales of CBD are flourishing in some European countries despite confusion around the European Food Safety Authority's classification of CBD as a "novel food". Some countries, such as the UK and Italy, have a hands- off approach and are not enforcing these guidelines, while other countries (e.g., France, Austria, and Spain) investigate these CBD sales. CBD products in some European countries are available from tobacco shops, vape stores, and traditional supplement stores like UK-based Holland and Barrett. These products are also in convenience stores, supermarkets, and online retailers, including Amazon.

Australia

Due to the regulatory environment, hemp is grown explicitly in Australia for food or industrial purposes. The many available industrial hemp varieties make the crop suitable for cultivation in various geographical farming locations across Australia. It is a high-yielding, hardy and fast-growing annual crop, which can be sown from early spring to late summer/early autumn. A large proportion of its production is irrigated. Commercial or trial hemp crops are grown in all states in Australia. Most Australian commercial production is in Tasmania. In the 2019-20 growing season, approximately 1600 hectares was planted in Tasmania, with a farm gate value of $4.5 million. This compares to 280 hectares planted in Western Australia and 200 hectares in Victoria.

Tasmania was the first state to permit hemp cultivation, and the growers have developed seed varieties suited to the Tasmanian climate. The Department of Primary Industries, Parks, Water, and Environment is responsible for issuing licenses to authorize industrial hemp's possession, cultivation, supply, and manufacture for non-therapeutic (non-medicinal) purposes. Tasmania's Industrial Hemp Act 2015 does not authorize cannabinoid extraction for any purpose. The legal THC threshold for industrial hemp products is consistent with other states, except in Victoria, at one percent. However, the hemp crop's seed genetics must not exceed 0.5 percent in THC level. By contrast, the Victoria THC threshold for plant and crop genetics is 0.35 percent.

In Victoria, industrial hemp is grown mainly to produce hemp seed, which can now be legally sold for food purposes. Most crops in Victoria are planted in spring. As hemp is a regulated plant, a person must hold Authority under Part IVA of the Drugs, Poisons and Controlled Substances Act 1981 to cultivate, process, sell or supply low-THC cannabis and low-THC cannabis seed. Approximately 200 hectares of hemp was planted in the 2019-20 growing season. In comparison, 170 hectares was cultivated in 2018-19 and 600 hectares in 2017-18. The reduction in plantings was primarily due to low water availability. Hemp may be cultivated for seeds or fibre, but generally not both at the same time.

A large increase in Victorian hemp Authorities was observed after the approval of hemp seed for use in food under the Australia New Zealand Food Standards Code in 2017. Most Authority holders cultivate hemp to produce hemp seed for food purposes and for selling seed to other growers for cultivation. Three Authority holders process hemp seed. This process usually involves de-hulling for food purposes or crushing to produce hemp seed oil. Only a small number of Authority holders are commercial broadacre farmers, with the remainder considered enthusiasts. These growers produce the bulk of the hemp seed. Larger growers include Waltanna Farms and Australian Primary Hemp (both located in the Western Districts). Except for Queensland, other Australian states and territories have standalone legislation to regulate the hemp industry. The hemp industry in Victoria is represented by Hemp Victoria (formerly the Industrial Hemp Association of Victoria).

Lesotho

Hemp was previously regulated under the Dangerous Medicines Act of 1973 (Government of Lesotho, 1978) and later superseded in 2008 by the Drugs of Abuse Act (Government of Lesotho, 2008). The change allowed the government to provide access to specific drugs for medical and scientific purposes. The International Narcotics Control Board (INCB, 2007) noted the efforts made by the Government of Lesotho to control drug cultivation and comply with the international drug control treaties; however, they also urged the introduction of alternative development programmes, with the assistance of international donors.

In 2018, Lesotho became the first African nation to issue licenses for the cultivation of cannabis for medicinal purposes and change existing legislation, and de-criminalise the cultivation of cannabis for medical use. The new law came into effect the following year through the Drug of Abuse (Cannabis) Regulations Act of 2018, and licenses would cost approximately €30,000 and are issued by the Lesotho Narcotics Board (Phakela, 2018). Foreign investors, including Canadian companies Supreme Cannabis Co., Canopy Growth Corp., and Aphria Inc., have since poured tens of millions of dollars into a handful of facilities, drawn by the low cost of production.

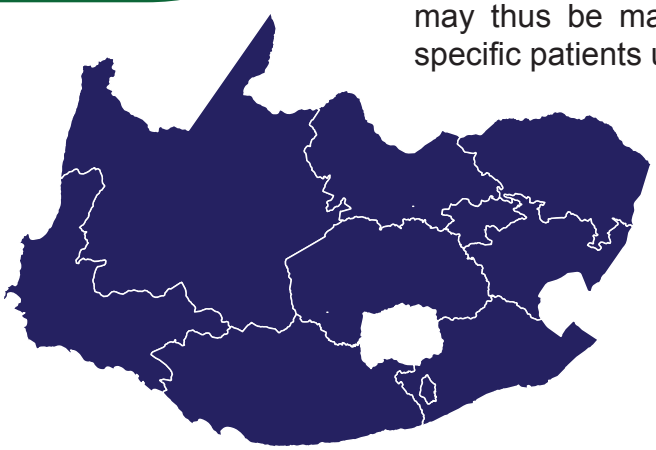
The Lesotho government is now trying to spur the development of legal plantations supplying the burgeoning global medical cannabis industry to broaden its tax base—currently dominated by exports of diamonds, water and wool—and create jobs. About two-thirds of the country's 2.2 million people live in rural villages, and many survive off subsistence farming. Cannabis is a critical piece of the government's agricultural strategy, which it hopes will help fund basic infrastructure s such as roads, electricity, and water pipes.

MG Health, Lesotho's biggest commercial producer, received C$10 million ($7.6 million) from Supreme Cannabis last year in exchange for 10% of the business known as Medigrow Lesotho (Supreme has said it eventually wants to export medical cannabis oils from Lesotho to Canada). MG Health plans to employ as many as 3,000 workers locally—up from about 350 currently—once it reaches full production in a few years, says Chief Executive Officer Andre Bothma.

South Africa

Requirements regarding permits and licenses to produce and sell medical cannabis in South Africa are currently demanding, and legal advice is necessary to participate in this sector. The Medicines and Related Substances Act of 1965 (Medicines Act) historically mandated the-then Medicines Control Council, now referred to as the South African Health Products Regulatory Authority (SAHPRA), to regulate the availability of quality medicines which are safe and efficacious for their intended use. This mandate requires SAHPRA to apply standards for the manufacturing, distribution, selling, and marketing of medicines, medical devices, and scheduled substances, including cannabis.

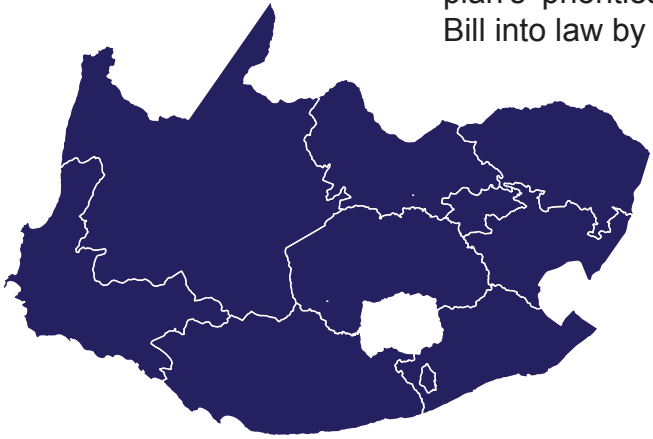
Regarding the Medicines Act, medical practitioners are permitted to apply to SAHPRA for permission to access and prescribe unregistered medicines when intended to treat their patients, including cannabis. Accordingly, SAHPRA acknowledges and permits that cannabis products intended for medicinal purposes may thus be made available in exceptional circumstances to specific patients under medical supervision.



Furthermore, under the Medicines Act and in line with the United Nations Single Convention, the cultivation, production, manufacturing, and use of medicinal cannabis products may only occur through a license issued by SAHPRA and a permit issued by the Department of Health. In the license, SAHPRA is mandated to inspect the plans for the facility and the quality-control procedure, amongst other things. In addition, potential growers are required to apply to the Director-General of Health for a permit to acquire, possess, manufacture, use or supply cannabis. Stringent quality control measures are necessary to ensure that the product is safe for medical use. Although there is no limit on the amount of cannabis that can be grown, as part of the application process, SAHPRA will allocate a permitted quantity.

Recent legal developments include the reassigning of Cannabidiol (CBD), which is a component of the cannabis plant, from Schedule 7 of the Medicines Act (being a highly regulated substance) to Schedule 4 (being substances that can be sold with a prescription). In addition, some CBD products and products with THC levels of less than 0.001 percent and less than 0.0075 percent of CBD were excluded from the list altogether, which means they can be purchased without a prescription. For licensed cannabis producers in South Africa, this has now opened a range of potential new markets for their products. That being said, CBD products that do not fall into the exemption continue to require a prescription by a medical practitioner to be sold.

In 2021, the South African government proposed a draft national master plan with the aim of loosening regulations in the cannabis industry to boost economic development. The plan looks at the prospect of creating an export market for cannabis producers and how current legislation can be amended to remove constraints on the commercial cannabis market. The plan also involves increasing investment in cannabis industry research. Other suggestions included in the plan support for farmers and indigenous growers in the cannabis value chain, as well as support for manufacturing and product development. One of the plan's priorities is signing the Cannabis for Private Purposes Bill into law by 2023.



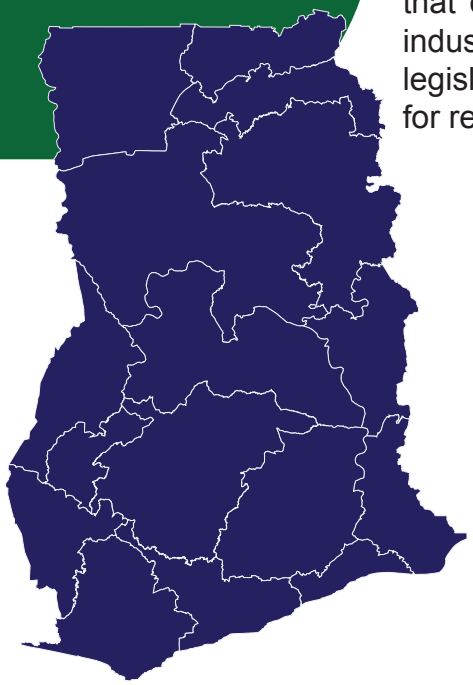
Ghana

In 2020, Ghana's parliament passed the Narcotics Control Commission Act, 2020 (Act 1019) (2020), which will allow the use and cultivation of cannabis for medical and industrial uses, but only the variety better known as hemp. This act was to repeal the Narcotic Drugs (Control, Enforcement, and Sanction) Act, 1990, PNDC Law 236, which criminalized possession or importation of narcotic substances (cannabis inclusive). A violation of the law was punishable by up to 10 years of imprisonment. Also, Act 1019 decriminalizes the use of cannabis for commercial and health purposes. The new law limits the allowable concentration of tetrahydrocannabinol (THC) in the plants – the substance that gets people high – to less than 0.3%. That's the same level made legal for cultivation in the U.S. by the 2018 Farm Bill.

However, cannabidiol (CBD), which is believed to provide health benefits, can be extracted from hemp. Recreational cannabis use remains illegal in Ghana.

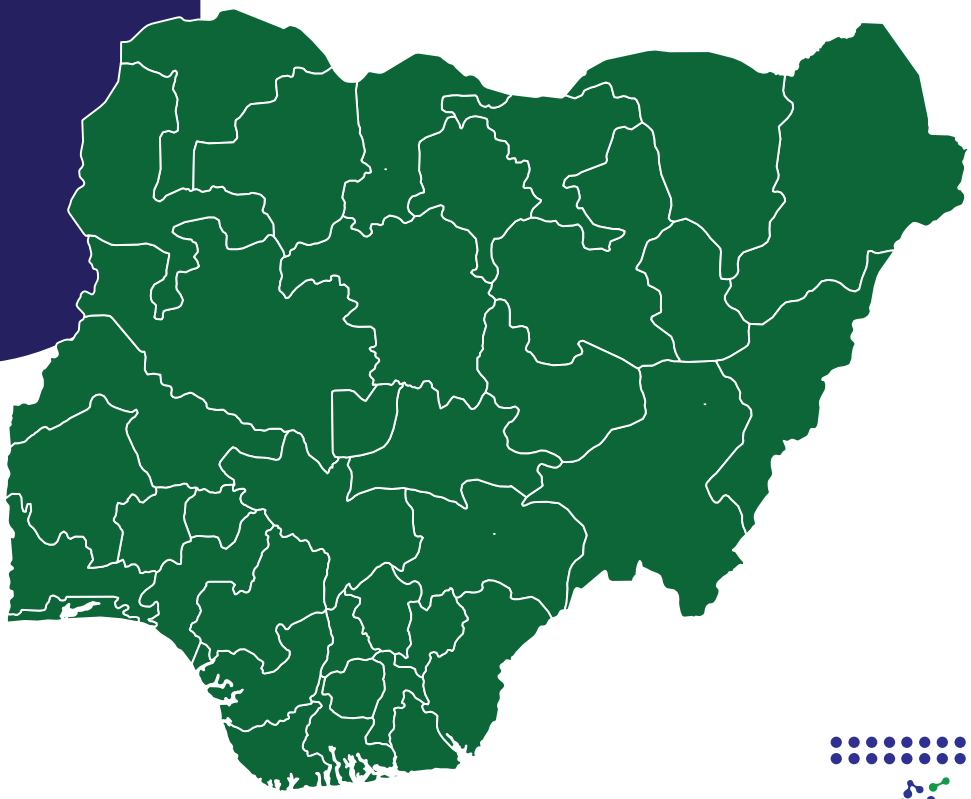
In Ghana, before the enactment of Act 1019, all cannabis species were classified as a narcotic substance, and unlawful possession Sections 1, 2, and 5 of PDNC Law 236 stipulated that; "anyone who wants to import or possess any narcotic substance had to obtain a license, which had to be granted by the Minister for Health. Also, anyone who imports a narcotic drug is supposed to submit the details to the Pharmacy council. Possession and usage of narcotic substances, including cannabis, even for medical purposes without following due process, are unlawful and punishable by up to 10 years of imprisonment."

Ghana adopts the legalization and commercialization approach for cannabis regulation. This is evident in the strain of cannabis that can be cultivated under license. The legislation allows for industrial and medical purposes only. However, others adopt legislations that do not only allow for commercialization but also for recreational purposes.



Nigeria

Because industrial hemp is sometimes confused with and perceived as the cannabis plants that serve as sources of the drug marijuana and the drug preparation hashish. A Bill for an Act to Regulate the Cultivation, Possession, and Trade of Cannabis for Medical and Related Purposes was proposed by a lawmaker representing Okigwe North Federal Constituency, Miriam Onuoha, in January 2021. Similarly, Governor Rotimi Akeredolu of Ondo State, one of the states with the most extensive Hemp plantations in the country, had repeatedly supported calls for the legalization of cannabis. Having presented the Dangerous Drugs Act amendment bill, 2020, to the House of Representatives for consideration, Ondo state leads the race to legalize Hemp in Nigeria. Maintaining the medical and economic benefits of the plant is enormous, and Nigeria is projected to make as much as USD145 billion in six years through legally cultivating and selling Hemp plants.



Utilizations of industrial hemp

General description of industrial hemp products

Industrial hemp and marijuana are genetically and chemically distinct forms of the Cannabis sativa plant. The plants are covered in tiny hairs called trichomes, which secrete a resin containing chemical compounds known as cannabinoids. Trichomes are found in the most excellent density in the female flowers of the plants, followed by the leaves, stalks, and roots.

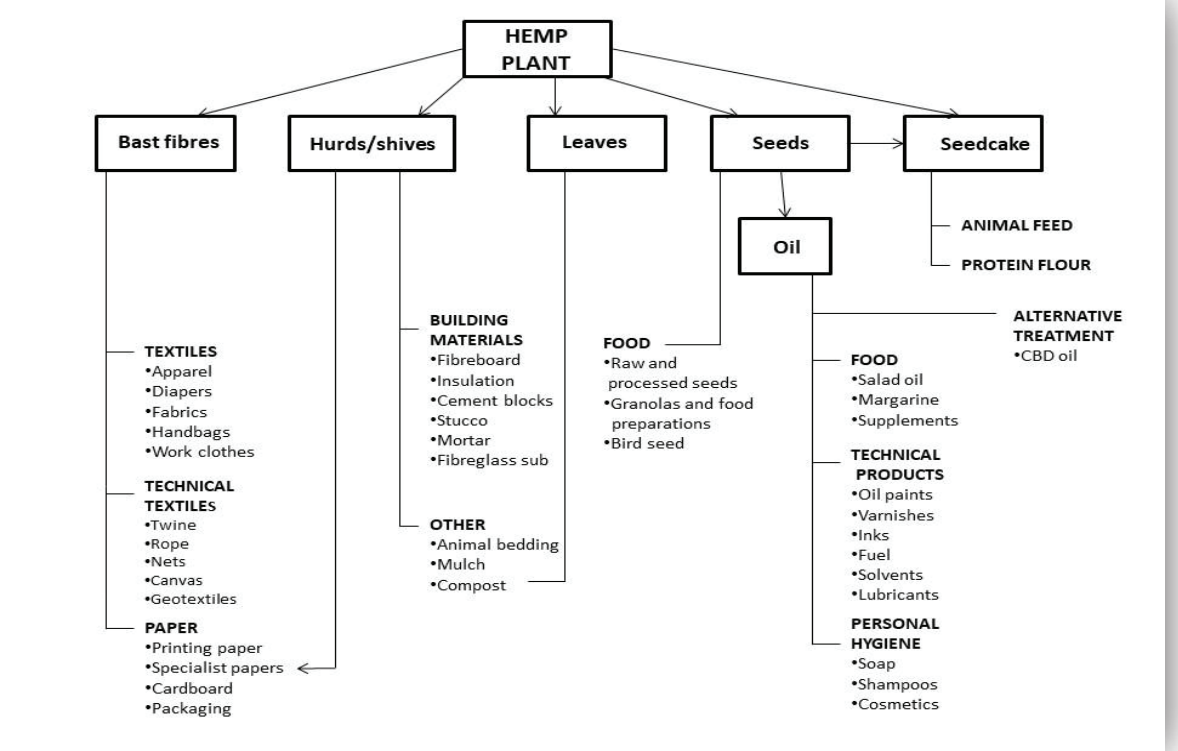
TABLE 4: COMPARATIVE CHARACTERISTICS OF MARIJUANA VERSUS INDUSTRIAL HEMP

	Industrial hemp	*Marijuana*
Plant species	Cannabis sativa	Cannabis sativa
Primary use	Agricultural crop: seeds, fibre, hurd, oil, seedcake	
THC	0.1–0.3 percent	9–40 percent
CBD	High	Low
Appearance	Long, thin plants	Bushy, squat plants
Growing requirements	High density, outdoor cultivation	Lower density, individual attention, indoor cultivation

Source: Based on Coogan (2016); Lowitt (2018).

The industrial hemp plant is a fast-growing, annual herbaceous plant with a deep tap root. Depending on the cultivar and growing conditions, it can grow up to 5 m high. The plant has a slender main stem and, when grown at commercial densities, the stems are almost unbranched. The stem comprises two parts: the bark or bast, which contains the long fibres used in textiles (about one-third of the stem), and the woody inner portion of the stem known as the hurd.

FIGURE 2 OVERVIEW OF THE USES OF DIFFERENT PARTS OF THE INDUSTRIAL HEMP PLANT



Source: Compilation from CRS report (2018); Lowitt (2020).

The hurd has much shorter fibres than the bast and accounts for about two-thirds of the stem. At the end of the growing cycle, the plant forms seed heads containing seeds, seed oils, and cannabinoid CBD. As will be seen in the cultivation section, different cultivars have different characteristics for hurd, bast, and seed properties; and different planting densities are adopted to encourage the desired characteristics (Table 2). Importantly, these different plant and cultivation traits suggest that differentiating between industrial hemp and marijuana is not as challenging as critics suggest. The crops would not look similar when cultivated for their specific end uses.

Hemp Fibres are predominantly used in textiles, paper manufacture, and—more recently and notably— in bio-composites.

- **Textile.** In terms of textiles, only high-quality fibres are used for clothing, apparel, and fabric weaving. Poorer-quality fibres are used for ropes and twine, canvas bags and tarps, carpets, and geotextiles. For centuries, hemp fibres have also been used in producing paper.

- **Paper.** In the modern era, bast-fibre paper is used to manufacture bank notes because of its tear resistance, tensile strength, and durability. Bast fibres are also used in producing ultrathin paper, such as those used in cigarettes and bibles. Recent technological innovation has enabled a third use of hemp fibre, namely the production of bio-composites.

- **Bio-Composites.** They are materials formed by a matrix (resin), which is then reinforced with natural fibres. Adding fibres makes a composite strong and shatter-resistant yet light and flexible. Used in civil works. These characteristics (as well as the green credentials of bio-composites) are highly sought after in the building, construction, and plastics and materials manufacturing industries. In building and construction, hemp fibre is used as a substitute for fibreglass and woodchips in producing lightweight, strong, flexible, and highly insulating fibreboards, insulation materials, concrete blocks, stucco, and mortar. These uses increase both the functional and environmental characteristics of the building materials. Used in manufactured products. The greatest adoption of bio-composites is observed in the automotive industry, where original equipment manufacturers (OEMs) and their suppliers are adding hemp fibres to plastic composites to produce injection-molded parcel shelves, and door panels, instrument panels, arm rests, head rests, and seat shells. This switch has been driven by performance requirements (especially weight) and EU legislation, which requires increased recyclability for end-of-life automotive parts. Audi, BMW, Ford, Honda, Mercedes, and Volkswagen use bio-composites. The choice of fibre between hemp, flax, and kenaf is based on cost and availability.

- Biomass and biodiesel. In the modern era, when green and renewable energy sources are increasingly sought, industrial hemp is also considered a source of both biomass and biodiesel. It is argued that the whole industrial hemp plant can be used as biomass for energy applications. However, the only commercial application currently is the niche market of pellets for residential woodburning stoves. Ethanol can, in principle, be produced from the cellulose in hemp fibre. However, the green credentials of industrial hemp as a renewable energy source are strongly contested, and the lack of research severely hampers analysis. The only fair conclusion to draw is that it is 'unclear whether hemp is any better than its competitors' (Fortenbery 2014: 11).

Hemp Seeds: Industrial hemp offers the second-highest source of protein in the plant kingdom, soybeans being 7 percent richer. Hemp seed oil is the oil obtained by cold expression from the ripened fruits (seeds) of Cannabis sativa. In addition, industrial hemp seeds contain eight essential amino acids and polyunsaturated fats ('good' fats). It is from these chemical characteristics that the plant derives its nutritional and 'health' credentials. Hemp seeds are sold either natural or roasted or are added to mueslis, cereals, chocolates, and numerous beverages. The seeds can also be ground into flour or meal and used to produce baked foods.

- **Hemp Seed Oil:** Hemp seed oil is the oil obtained by cold expression from the ripened fruits(seeds) of Cannabis sativa. Used as a food. Hemp oil is easily oxidized when exposed to heat and light. This makes it ill-suited to cooking, but it is an attractive alternative to butter and margarine in salad dressings. The fatty acid profiles of hemp oil are high in linoleic and alpha-linoleic acids, which are crucial in skin care. As a result, there is a growing market for natural cosmetics and body care products made with hemp oil. These include shampoos, soaps, bath gels, lip balms, body lotions, massage oils, and colour cosmetics. Used as medicine or therapeutic. A key demand for industrial hemp is argued to derive from the massive global demand for CBD oil, which can be extracted from the trichomes covering the flowers, leaves, and stalks of the industrial hemp plant. This use is sometimes characterized as the medicinal or therapeutic use of the plant. The illegality of growing Cannabis sativa has hampered research into CBD oil, but increased research and evidence are accumulating as legislation is relaxing. CBD oil is a 'wonder' natural medicine/therapy with strong anti-inflammatory, anti-seizure, and anti-nausea properties. Other claims are that the oil helps lower blood pressure and cholesterol, strengthens the immune system, and works as a sleep aid. The CBD market is dealt with in more detail below, as it is seen as the current market's best income-generating downstream product of the hemp plant.

- **Hemp Seedcake:** Once the oil has been extracted from the seed, the residual matter is known as oilseed cake or seedcake. Because of its high residual protein content and amino and polyunsaturated fatty acids, seedcake makes an especially good animal feed. Existing research shows that cows, sheep, fish, and egg-laying hens all thrive on the product.

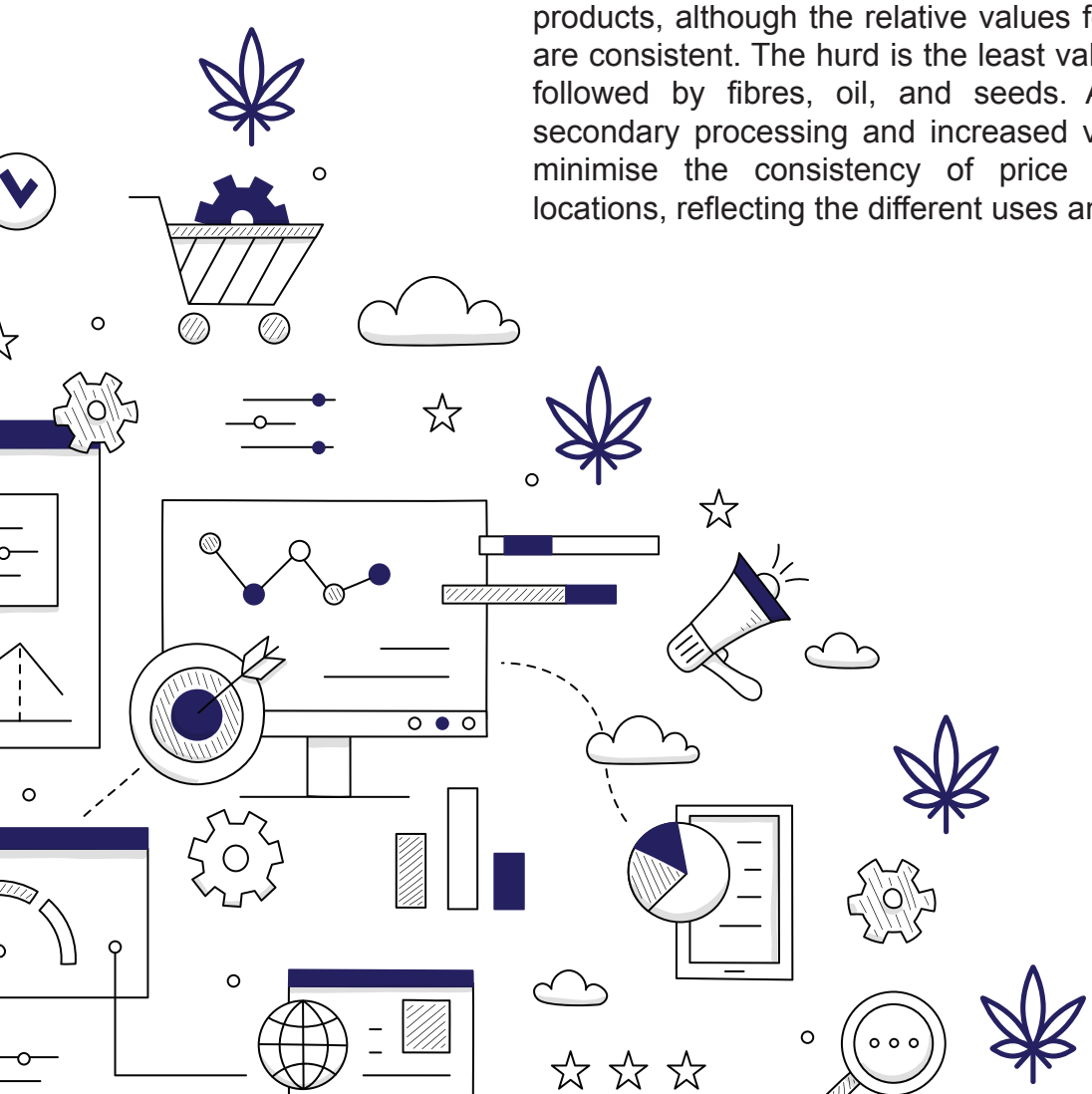
Hemp Hurd: The plant's woody inner core, the hurd, makes high-quality animal bedding because of its super absorbent properties. It is more absorbent than woodchips and has found particular favour in Europe, where it has become the bedding of choice for horses.

PRICING AND MARKETING OF INDUSTRIAL HEMP

Pricing upstream resources and downstream end-use products

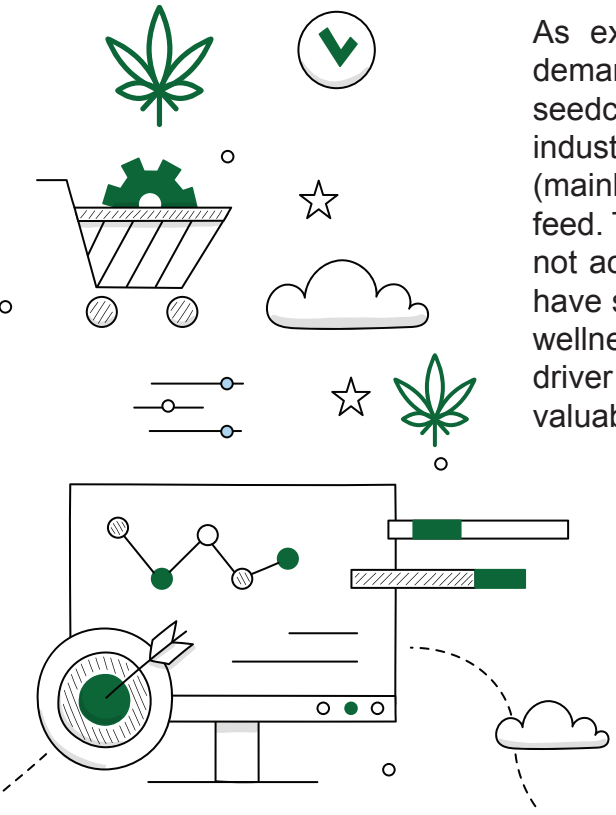
Commercial viability calculations are crucial when reallocating resources to cultivate an alternative, novel crop. Given the lack of official data, a lack of time series data on price movements, and only experimental- scale cultivation cost and yield data, developing a view on the feasibility of industrial hemp is fraught with difficulties. The data referred to in this section derive from feasibility studies in the US, Australia, and South Africa. Also, the selling price of upstream and downstream products is the key to any opinion on commercial viability. As with any agricultural crop or feedstock, market prices increase as value is added down the value chain.

Unprocessed industrial hemp plant material (stalks and leaves) was selling for as little as USD219 per tonne in 2015 in the US; however, values increase as soon as the plant is processed. In Table 3, we observe high variation in absolute values for different products, although the relative values for the downstream uses are consistent. The hurd is the least valuable processed output, followed by fibres, oil, and seeds. At the same time, the secondary processing and increased value addition appear to minimise the consistency of price differences across the locations, reflecting the different uses and demand.



In South Africa, limited value is attributed to the less beneficiated products of the industrial hemp value chain. Prices for fibre, hurd, and even seedcake as an alternative source of protein for animal feed suggest low market knowledge, acceptance, and interest compared with higher-value-added uses. Hemp oil (used for human food consumption and as an input to cosmetics and personal care products) and shelled seeds are fairly equal in value and demonstrate market knowledge and interest in the health and wellness aspects of industrial hemp. Finally, CBD oil extraction from the plant returns the highest market price by a massive margin. However, this finding is problematic from a sustainability perspective for industrial hemp cultivation in South Africa. The differential should be seen as a short-term boom, which will disappear as marijuana legislation changes, synthetic substitutes are developed, and the input product becomes commoditized as supply increases.

In Australia, the leading market opportunity identified by the price differentials is the use of industrial hemp as a 'super food', with the highest prices being identified for seeds—especially organic seeds. This market opportunity matches the characteristics of the Canadian industrial hemp market, where the dominant consumer demand is for the wellness and health benefits of the product. Canada also shows the additional value of organically cultivated seeds, with a 40 percent premium attached (Crawford et al. 2012). Unlike South Africa, Canada and Australia have medical marijuana programmes. Thus, an industrial hemp-derived CBD oil market is almost non-existent, as consumers prefer the higher quality marijuana- based product.



As expected, the US market represents a more diversified demand pattern. In this market, the best prices received are for seedcake, suggesting that the US farming community values industrial hemp seedcake as a viable alternative to existing (mainly soya) seedcake, i.e., a high-protein additive to animal feed. These prices appear only in the US; comparable prices are not achieved in Canada, Australia, or South Africa, all of which have substantial poultry and livestock sectors. Consumer-driven wellness-inspired demand for hemp oil and seed is the next big driver of value in the US market, with seed becoming more valuable over time, according to time series data.

TABLE 5: RELATIVE PRICES FOR UPSTREAM AND DOWNSTREAM HEMP PRODUCTS

Product	South Africa Rand/Kg (2015)	United States USD/Kg (2013)	Australia AUD/Tonne (1995)
CBD oil extract	10,000.00	-	-
SEED-DERIVED			
Hemp seeds	115.00	9.08	1,200.00
Hemp oil	100.00	5.03	-
Seedcake	50.00	10.45	-
Organic seeds	-	-	1,680.00
FIBRE-DERIVED			
Stalk fibre	9.00	-	-
Stalk hurd	6.00	-	55.00
Dry hurds	-	-	40.00
Fibre & waste	-	1.08	-
Raw stalks	-	-	55.00
Dry stems	-	-	125.00
Raw fibres	-	-	647.00
Dry fibres	-	-	800.00
Bast fibres	-	-	630.00
Yarns	-	6.89	-
Woven fabric	-	4.72	-

Source: Crawford et al. (2012); Fortenbery (2014); Coogan (2016).

This reflects that, as in the other three markets, US demand for industrial hemp as a health food input and standalone seed is strong and gaining momentum. Importantly, Fortenbery's study did not consider the use of industrial hemp as a source of CBD oil. In a series of newspaper articles documenting experiments by Kentucky tobacco farmers who were turning to industrial hemp production, all the interviewed farmers related that they were cultivating industrial hemp solely to produce CBD oil. They claimed that they were achieving USD30,000 per acre when the crop was turned into CBD oil, but as final yields are not known, it is difficult to compare these prices with per kilogram prices from South Africa, Australia, and Canada. Nevertheless, as in the other case studies, it is fair to assume that processing industrial hemp into CBD oil achieves the highest price of all alternative uses in the US.

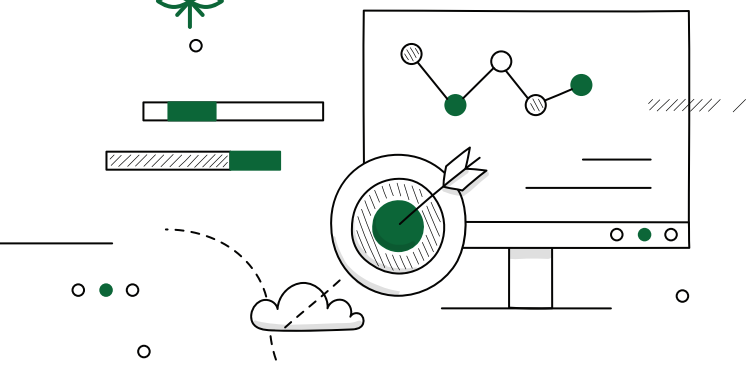
In general, it can be argued that the two largest drivers of demand for industrial hemp end-use products outside China are industrial hemp seed as a health food input and industrial hemp as a source of CBD oil. Fibre prices may improve in the future as more industrial substitute products such as bio-composites and tree-free paper are demanded. Still, current price signals indicate that focus and demand are driven by the health food and CBD markets, followed by the oil market as input for personal care and cosmetic products. Market prices for industrial hemp fibre for fabric and apparel production remain relatively low.

Projected effect of Industrial hemp producers' margin on marketable volume and pricing

Regarding achievable producers' margins, the reviewed case studies in Australia and US looked at non- CBD uses only. The Australian study makes assumptions about input costs and yield. It then computes the margin per hectare in Australian dollars based on a high-, medium-, and low-price scenario. It is important that the input costs are relatively higher when the crop is produced for seed than for fibre. The authors compared these margins with the gross margins of other crops; the findings are presented in Figure 3.

FIGURE 3: COMPARATIVE GROSS MARGINS PER HECTARE OF CROPS IN AUSTRALIA, AUD/HECTARE

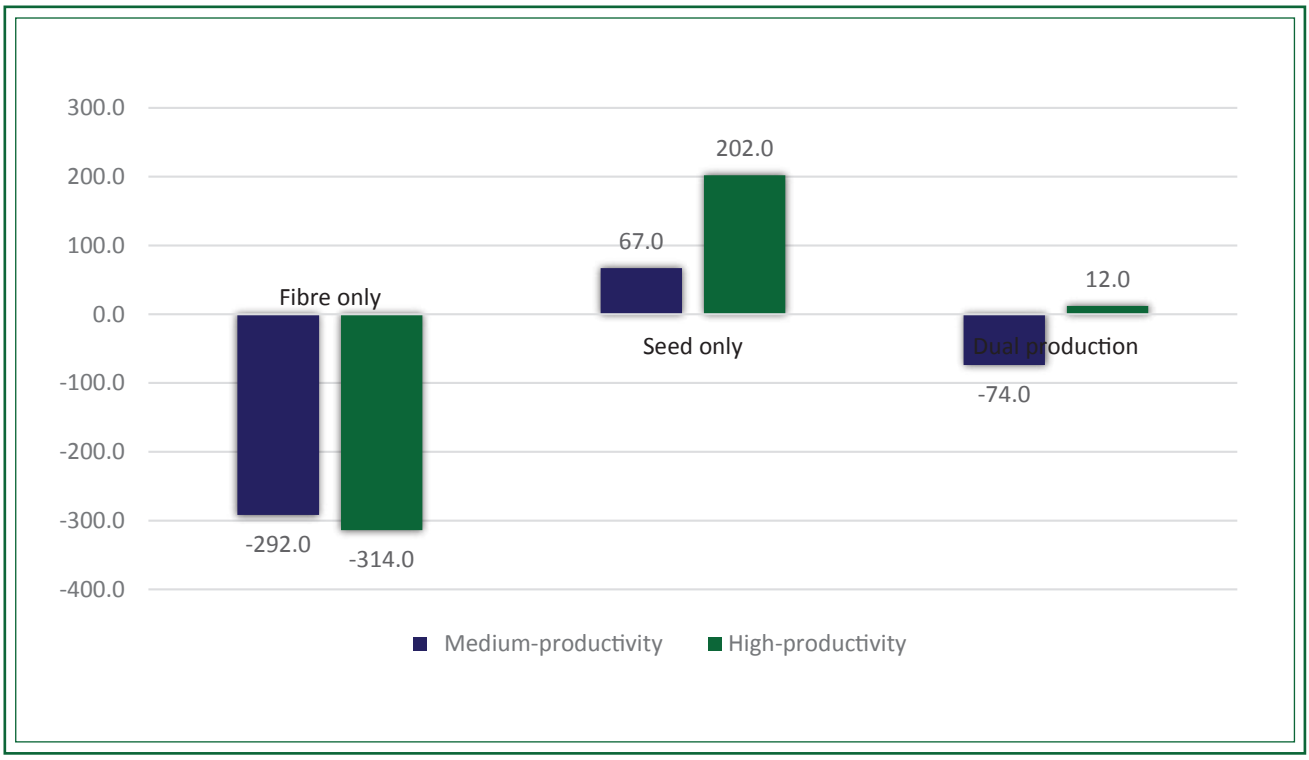
Source: Compilation based on Crawford et al. (2012); Lowitt (2020)



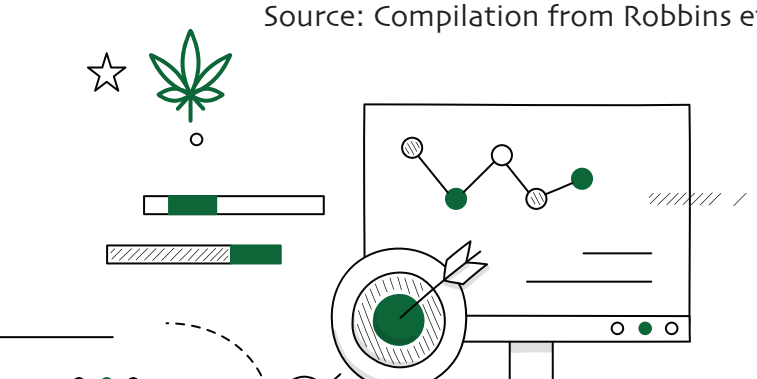
Australian Scenario: The Australian data show that cultivating industrial hemp for the end-use of seed is competitive compared with other crops at a high global price. Farmers would be better off growing canola at a medium price, and at a low price, farmers would be better off producing any other agricultural crop. This scenario is relevant and highly illustrative of one of the current critical problems with the industrial hemp market that the traded volumes are small, and markets are thin. Also, global production is shared across only a handful of countries, with China dominating global supply with a 70 percent share of world exports.

China's production decisions disproportionately impact the global price, as seed producers discovered at the end of the 1980s. The country has consistently grown industrial hemp for fibre and supplied this to the domestic market, only a small percentage of output being exported. Before 1986, China had never produced industrial hemp seed. Between 1986 and 1988, China shifted its cultivation priorities from fibre to seed. According to Crawford et al. (2012), between 1986 and 1991, China's global share of the seed market increased from 0 percent to 76 percent. As a result of this shift, the volume of hemp seeds on the global market increased from 5,000 tons to 18,000 tons in the same period, leading to a total collapse of the seed price. In 24 months, prices fell by 43 percent, from 26 cents per pound to 15 cents per pound. In 1992, China abruptly decreased its seed production, globally traded volumes fell to 7,000 tons, and prices recovered to 23 cents per pound. High price volatility and its impact on farmer margins threaten any market with low traded volumes. This is one of the difficulties in establishing novel crops as mainstream crops.

FIGURE 4 LOW PRICE NET RETURN SCENARIO PER ACRE, USD



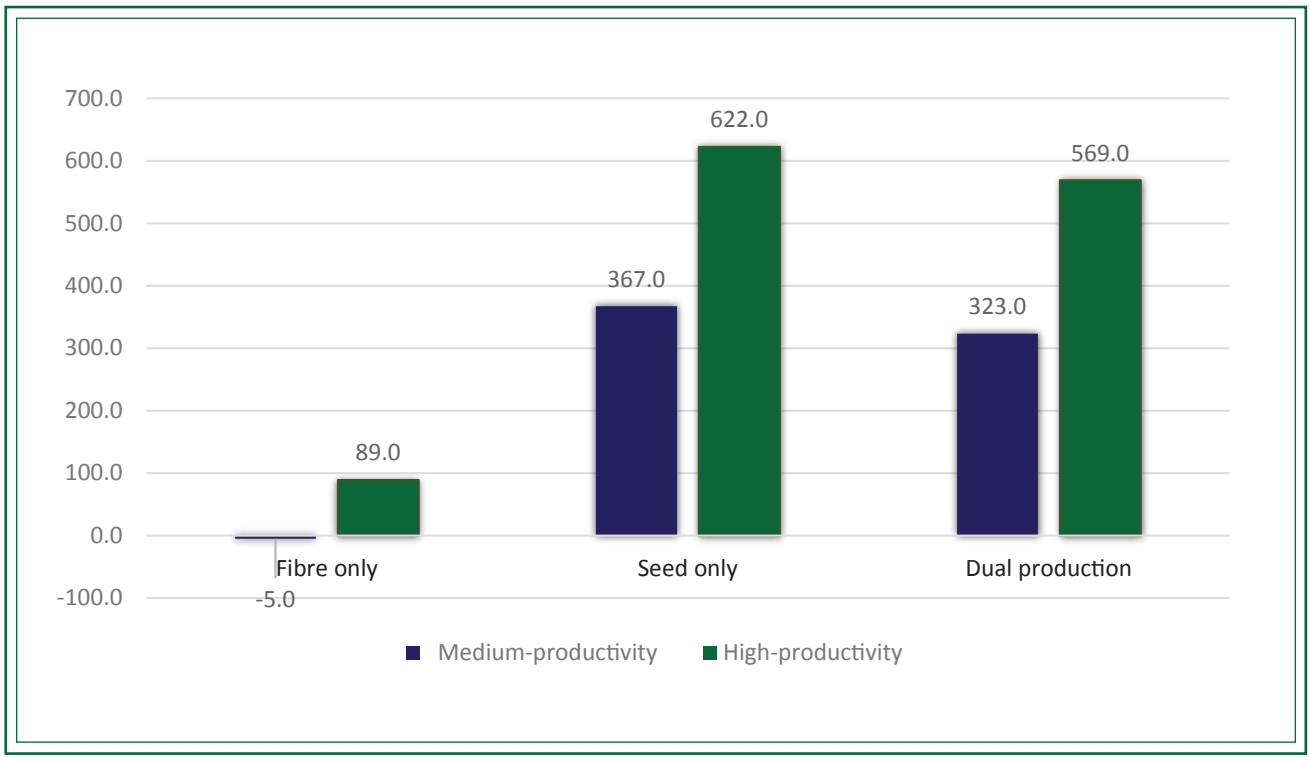
Source: Compilation from Robbins et al. (2013).



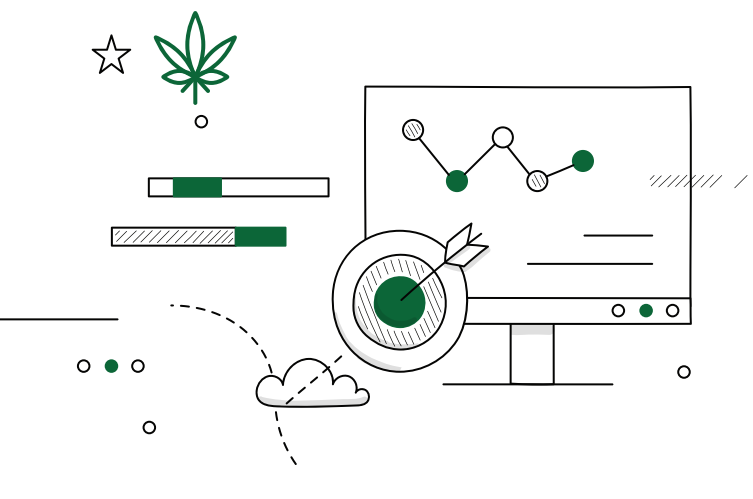
LINKS
Catalysing Economic Growth for Northern Nigeria

United States Scenario: The most detailed and comprehensive reporting on possible net returns from growing industrial hemp comes from the 2013 work of Robbins et al. Their study was explicitly undertaken to consider the crop as an alternative to tobacco in Kentucky. Interestingly, as a response to thin markets, price volatility, and uncertain future demand, Robbin's work considers the concept of cultivating industrial hemp for more than one end-use product. As shown in Figures 4 and 5, the research looks at the potential of growing industrial hemp for fibre and for seed. It looks at a low-price scenario—fibre selling at USD50 per ton and seed selling at 50 cents per pound — and a high-price scenario — fibre selling at USD100 per ton and seed selling at 90 cents per pound. Also, the authors examine the effect of land quality on the crop and distinguishes between medium-productivity land and high-productivity land.

FIGURE 5: HIGH PRICE NET RETURN SCENARIO PER ACRE, USD



Source: Compilation from Robbins et al. (2013)



Findings from study show that a fibre-only crop would be viable only in a high-price scenario using high- productivity land, thus probably not making it an attractive option, especially given Chinese production volumes of fibre. Seed-only production provides a positive return at either a high or a low price, but net returns increase substantially using high-productivity land. Given the poor returns on fibre, dual production for fibre and seed is less profitable than seed production only. This is backed up by technical findings showing that the quality of fibres is reduced when a plant is bred to produce both seed and fibre (Amaducci et al., 2015).

General view on commercial viability of industrial hemp including CBD oil

Controlling for CBD oil in the mix of potential uses of an industrial hemp crop skews all existing findings and rationales for hemp as an agricultural crop. Based on the price differential results, in the short to medium term, industrial hemp will be cultivated for CBD oil as an end-use product except in countries where medical cannabis cultivation is legalized, such as Australia, Canada, and US. As previously discussed, the CBD content of marijuana is greater than that of industrial hemp, and industrial hemp CBD oil is dirtier and lower quality than its marijuana alternative. This means that producing CBD oil from a marijuana plant will be more commercially viable than producing CBD oil from an industrial hemp plant. In countries where medical marijuana has been legalised, CBD oil will be produced from marijuana crops, not industrial hemp. But in countries where industrial hemp cultivation is legalised but marijuana cultivation is not, a gap in the market exists for CBD oil from industrial hemp to meet demand. Therefore, as more countries legalize and decrease the regulation of industrial hemp cultivation, the supply of industrial hemp will increase, increasing the global supply of CBD oil and driving down its price. This commoditization of CBD oil would mirror the trend already established in the medical marijuana market, where in three years, prices for medical marijuana in Colorado, for example, decreased from USD5,000 per pound to USD800 per pound.

General view on commercial viability of industrial hemp excluding CBD oil

It appears that with current market dynamics and prices, the best possible end use for industrial hemp grown as an agricultural crop would be to cultivate for seed to meet the demand for healthy food inputs, raw seed consumption, and the possibility of extracting oil from the seed for personal care and cosmetic products. Production for fibre does not appear viable currently and would be in direct competition with the current world leader in hemp production—China. However, available evidence all agree that growing industrial hemp for seed for human consumption will require additional inputs compared with growing industrial hemp for fibre, biomass, or other industrial uses (e.g., EIHA, 2018). Thus, increasing production costs and decreasing the environmental benefits of the crop. Growing for seed requires gentle handling of the flower to minimize shattering. Labour-intensive harvesting methods can be considered competitive with mechanical harvesting, as would be done in developed countries. Nevertheless, the seed market is currently the most robust end-use market. With Australia and the EU reconsidering regulations to make seed legal for human consumption, future demand trends look positive. Furthermore, recent viability studies conclude that industrial hemp is slightly more profitable than other row crops but less profitable than specialty crops (e.g., J ohnson, 2018). The authors emphasise that current markets are thin and prices highly volatile, hence, decisions to shift to industrial hemp production would have to be based more on a view of future market potential than existing market opportunity.

Defining the demand drivers for the Industrial hemp market

Evidence shows that industrial hemp production is limited, demand is thin, and the volumes traded are low. Therefore, our analysis of commercial viability and investment decisions in the value chain is based on projections and perceptions of likely market development rather than existing market opportunities. Furthermore, studies show that the proposition of industrial hemp as a crop with enormous opportunities for growth falls into three groups.

Adaptability to different agroecology.

Authors argue that industrial hemp is 'the farmer's best friend'. Multiple landrace strains exist in almost all climates and soil conditions, making industrial hemp an extraordinarily flexible and unfussy plant to cultivate. The plant is easily hybridised, and cultivars and varieties can be bred to support specific plant characteristics within just seven generations. The plant is a fast grower, meaning it naturally suppresses weeds and hence largely eliminates the need to use expensive herbicides. The plant also improves soil health—especially aeration. The plant's ability to improve the quality of the soil plus its rapid growth make it a perfect rotational crop, and it has been found that food crops can be grown on a plot used for industrial hemp immediately after the hemp harvest with no fallow period required. In addition, research shows that wheat and soybean yields improve sharply when industrial hemp is the preceding crop (Amaducci et al., 2015). Industrial hemp grows well when rain-fed and does not require irrigation. Finally, much is made of industrial hemp's potential to produce an income stream for farmers above current agricultural crops in general and tobacco in particular. This argument is dealt with below when market prices and commercial viability are considered.

Environmental Concerns

Another argument is made in favour of lifting the ban on industrial hemp and supporting the agricultural crop's growth and development at scale based on its green credentials.

- First, industrial hemp is considered less environmentally degrading than other agricultural crops. This is largely related to the argument that industrial hemp is typically ***a low-input, low- management, and low-technology crop.*** Hemp proponents argue that the crop is highly pest- resilient and disease-free, resulting in the need for fewer pesticides. The plant's fast growth pattern makes it a natural weed suppressant, meaning no herbicides are required. It is also argued that the crop needs fertilizer less than competing agricultural crops. These three facts, taken together, support the argument that the crop requires lower levels of inputs, thus decreasing its negative environmental impact during cultivation (Amaducci et al., 2015; Fortenbery, 2014; Heister, 2008).

- Environmentalists also argue that industrial hemp has ***excellent carbon sequestration properties*** and that one hectare of industrial hemp can absorb 15 tonnes of carbon dioxide (EIHA 2018). However, the low-input usage of industrial hemp is contested, the general counter-argument being those input requirements will depend on the intended final use of the crop. If it is grown for fibre, input requirements and management demands will be low. On the other hand, if it is grown for seed, the inputs and management are required to increase substantially, thus diminishing the environmental benefit of the crop (Coogan 2016; Dietz 2013; Fortenbery 2014; Heister 2008).

- The real focus of the environmental argument, however, has less to do with industrial hemp's green credentials as an agricultural crop and more to do with the green credentials of downstream industrial hemp products and the ability of industrial hemp-based products to ***provide sustainable alternatives to fossil fuel-derived mainstream products*** such as polyester, concrete form blocks, insulation, and lubricants. It is argued, for example, that industrial hemp provides a potentially lower-impact feedstock for paper manufacture than trees; that industrial hemp fibres have a lower environmental impact than cotton in the textile industry; and that industrial hemp substitute products increase the recyclability of final products at the end of their useful life.

In 2005, Cherrett et al. compared the ecological footprints of cotton, polyester, and industrial hemp. The calculation was based on the amount of land (measured in global hectares) required to provide all the necessary resources and absorb associated carbon dioxide waste to produce a given textile unit (Cherrett et al. 2005). Table 2 shows the three alternative products' findings for crop cultivation and fibre production. Hemp emerges as having the lowest ecological footprint of the three textiles. For hemp, crop cultivation creates a greater ecological footprint than fibre production because of the amount of land used for cultivation. However, the crop cultivation footprint of hemp is superior to cotton because of higher yields for hemp (3 tonnes/hectare versus 1.35 tonnes/ha for cotton) and lower water usage (3,400 litres/kilogram for hemp versus 9,750 l/k for cotton). Polyester obviously has no crop cultivation footprint but has a high fibre production footprint due to the extraction of its polymers from fossil fuels. The fibre production of hemp has a slightly greater footprint than cotton. Still, analysts seem to agree that this is large because no commercial research and development (R&D) have been done on natural fibre production, in contrast to the 50-year legacy of production and processing improvements in the cotton industry.

TABLE 6: ECOLOGICAL FOOTPRINT OF COTTON, INDUSTRIAL HEMP, AND POLYESTER COMPARED (GLOBAL HECTARES PER TONNE OF SPUN FIBRE)

Product	Crop cultivation	Fibre production	Total ecological footprint
Industrial hemp	1.0	0.4	1.4
Polyester (Europe)	0	1.7	1.7
Polyester (US)	0	2.1	2.1
Cotton (US)	2.6	0.3	2.9
Cotton (Punjab, India)	3.2	0.3	3.5

Source: author's construction based on Cherret et al. (2005).

Industrial hemp as a feedstock substitute for wood in paper production has also received a lot of attention. In North America particularly, sensitivity to the protection of forests is driving a growing demand for tree-free paper. Industrial hemp has a higher cellulose content and a lower lignin content than wood pulp, which is good for producing paper. In addition, hemp paper resists discolouration, is more durable than wood-based papers and decomposes more easily. Unfortunately, because of the seasonal nature of the crop, it cannot compete on input production costs with managed forests, especially new eucalyptus tree forests, which have low water requirements and provide high levels of cellulose in the pulp. Therefore, there tends to be a consensus that industrial hemp-based paper will remain a niche market (Cherney and Small 2016; Coogan 2016; Young 2005).

The environmental credentials of other value-adding industrial hemp-derived products are constantly being researched and updated as research scientists gain access to sufficient quantities of industrial hemp on which to base comparative exercises. For example, in an assessment of industrial hemp for building applications, Ingrao et al. (2017) found that hemp-based insulation produced superior heat retention properties than mainstream alternatives (principally fibreglass) and that such performance was achieved with lower fossil fuel usage and lower emissions. Similarly, the auto industry has shown that natural fibre bio-composite instruments and door panels are less brittle and stronger than pure plastic alternatives and have the added advantage of increased recyclability at the end of life of the car.

A final aspect of the green credential argument relates to industrial hemp as an alternative sustainable feedstock to fossil fuels. For three decades now, energy crops have been reported to have high potential to provide an increased share of renewable energy. Using land for energy production means that it is not available for food production; thus, given limited arable land, any use of land for energy production must achieve very high efficiency in terms of yield. (1) The entire plant can be used. Prade et al. (2011) argue that most bio-energy products derive from grains and seeds from conventional food crops, such as ethanol from wheat grains or biodiesel from rape seed. With industrial hemp the entire plant can be used, hence potentially allowing higher land use efficiency. (2) An annual crop and can be grown in rotation. In addition, industrial hemp is an annual crop and can be grown in rotation, which once again increases the sustainability of potential bioenergy production. These two characteristics have led some researchers to conclude that 'industrial hemp has a high energy yield for both solid fuel and biogas production similar to or superior to that of most energy crops common in the Northern hemisphere' (Prade et al. 2011: 3047). Cherney and Small (2016) disagree and argue that, although hemp has appealing attributes as an energy crop (low input needs, good rotational crop, and use of the entire plant), its bulkiness means that it will not be cost-effective to ship to processing centres; hence it has less potential for biomass than existing crops.

Health and food safety concerns.

The last argument in favour of industrial hemp relates to its food, personal care, and therapeutic uses. These three uses collectively account for 64 percent of current industrial hemp product sales in the US retail market (Johnson 2018). As mentioned, industrial hemp seed is considered a new 'super food' due to its high protein content, a predominance of 'good', polyunsaturated fats, and high omega-3 and fatty acids. Raw seeds are sold in some health food shops, but in most instances, processed dehulled seeds are sold as a standalone product or as part of 'healthy' cereals, mueslis, and other processed snacks. Despite always being consumed in China and other developing nations and legalized for human consumption in the US and Canada (the largest current markets), industrial hemp seeds cannot legally be produced for human consumption in Australia or Europe, where they may only be sold as bird seed. In both the EU and Australia, however, new health findings and trends mean that legislative changes to allow human consumption is in progress (EIHA, 2018). Imported seeds for human consumption that have met food standards in other countries are now available in the EU and Australian markets. As shown below, trade volumes in industrial hemp seeds for human consumption have increased consistently over the past ten years, with prices rising substantially as demand outstrips supply (Johnson 2018).

There are no dissenting views on the health benefits of industrial hemp seeds, hemp oil, and hemp-seed flour, so there are no disagreements on the attributes and marketability of hemp oil-based personal care products. Current product lines run the gamut from soaps and lotions to shampoos and cosmetics. The active compounds found in the plant have proved to be beneficial for skin health. The shift towards sustainable, natural, and environmentally friendly personal care products is well established and growing strongly in developed countries. For example, industrial hemp personal care products account for 24 percent of total industrial hemp retail product sales in the US (Johnson 2018).

It is noteworthy that the most controversial and often misunderstood argument for lifting restrictions on industrial hemp relates to the merits of CBD oil and its medicinal and therapeutic uses. CBD oil is claimed to relieves inflammation and pain, lowers cholesterol and blood pressure, reduce seizures, and aid sleep. However, to date, all rigorous testing of CBD oil as a medicine, therapy, or health supplement has been based on medically grown narcotic cannabis and not commercially cultivated industrial hemp.

Difference between CBD oil in Industrial hemp and Marijuana

Although, in theory, a CBD molecule is a CBD molecule, whether it is derived from industrial hemp or its narcotic cousin marijuana. However, in practice, important differences need to be considered before taking a view on the commercial viability of industrial hemp-based on cultivation for CBD oil uses.

In recent years, increasing amounts of research have demonstrated the medicinal features of cannabis relative to industrial hemp.

Marijuana has a higher mixture of cannabinoids and terpenes to deliver an 'entourage effect'

Medical therapies derived from marijuana include CBD, THC, and a multitude of other cannabinoids and terpenes found in the resin secreted by the tiny hairs on the flowers of the Cannabis sativa plant. This mixture of cannabinoids and terpenes is said to deliver an 'entourage effect'—i.e., largely unexplained benefits that are not present when only individual cannabinoids such as CBD are used in isolation or when THC or CBD are synthetically created. Thus, the medical marijuana movement is based on a mixture of CBD, THC, and other cannabinoids and terpenes. Pure CBD oil, with no THC or other cannabinoids and terpenes, will not be as medically effective as medical cannabis oil. This explains why in the largest medical cannabis market in the world at the moment (the US) CBD-only oil sales account for just USD190 million out of a legal cannabis market (CBD plus THC) of USD2.5 billion (Lowitt 2018).

Marijuana is grown indoor and absorbs less contaminants from the soil.

A second important difference between medical marijuana and CBD oil from industrial hemp relates to cultivation techniques and practices. Medical-grade marijuana is grown indoors in a strictly controlled environment. No cross-pollination or rogue plant invasion is possible; the planted crops are cuttings from existing plants (not seeds) to ensure identical genetic and chemical fingerprinting across generations; and moisture, nutrients, light, and humidity are all carefully controlled to maximize yield and crops per annum. There are multiple reasons (besides legislative reasons) why medical marijuana must be cultivated indoors, but a large driver is a fact that the Cannabis sativa plant is a bio-accumulator. This means that the plant absorbs contaminants from the soil, especially heavy metals. If industrial hemp is grown outdoors, it will absorb all kinds of contaminants, so any CBD oil derived from the plant will be 'dirtier' than its medical marijuana equivalent. Therefore, medical-grade CBD oil can be sourced only from indoor cultivated medical marijuana plants.

Marijuana plants contain higher quantity of CBD content.

From a commercial perspective, perhaps the most critical difference between CBD oil derived from industrial hemp and medical marijuana lies in the CBD content of the two plant cousins. Industrial hemp plants contain only 3–5 percent CBD, whereas marijuana plants contain 18–20 percent. This means that a large amount of industrial hemp plant material is required to produce even small amounts of oil. Given that the plants are bulky and transportation costs substantial, industrial hemp-derived CBD is less commercially viable than marijuana-derived CBD. This explains why outdoor-grown industrial hemp- derived CBD oil is not medical or pharmaceutical grade. In addition, CBD oil has limited medical and therapeutic characteristics compared with its much more effective marijuana-based alternative, which include the entourage effect when there is a combination of CBD, THC, and other cannabinoids and terpenes.

Medical-grade Marijuana use solvent extraction

Industrial hemp CBD oil is derived from the cold press extraction of hemp oil from the seeds. In contrast, medical-grade cannabis and CBD oil use solvent extraction or supercritical carbon dioxide fluid extraction. These different extraction processes also mean that CBD oil derived from industrial hemp is of poorer quality and less pure than that extracted from medical marijuana.

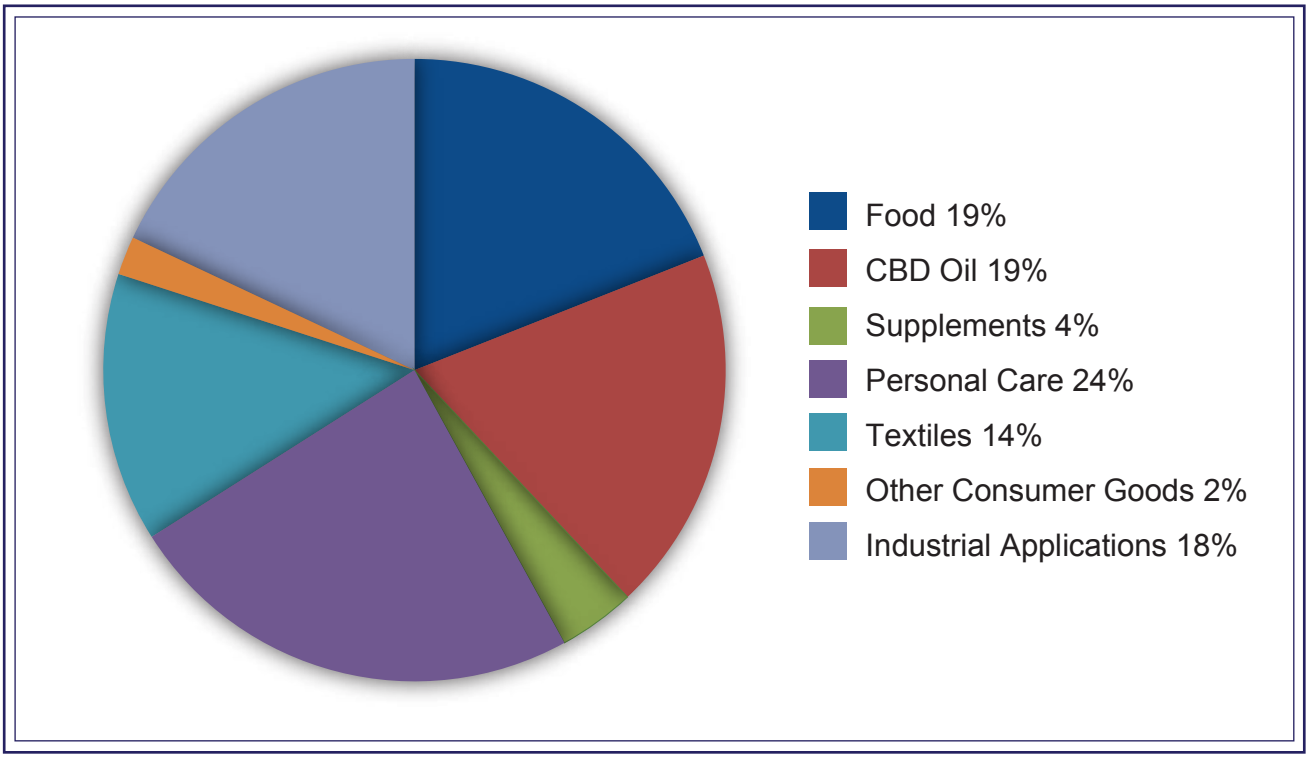
Despite these factors, much is still written about the potential of producing industrial hemp-derived CBD oil. This advocacy is understandable given the massive potential income stream attached to the production of CBD oil of any quality, the lack of access to medical-grade CBD oil derived from medical marijuana plants, and the current regulations applicable to CBD oil derived from industrial hemp.

Demand and consumption patterns for industrial hemp products

It is impossible to accurately assess global and individual country demand and demand patterns over time because of a lack of official data. While unofficial global data are also unavailable, data from the European Industrial Hemp Association and the US's Hemp Industries Association describe a general trend toward increased trade and retail sales over time. Unsurprisingly, total values remain low in absolute terms. For example, the most prominent individual retail market for industrial hemp and its products is the US, which in 2017 was estimated to have a domestic market valued at just US$700 million (Johnson 2018). While the two associations provide little help about the value of the industrial hemp trade, they provide essential information on different categories of demand. What emerges is that the two largest markets for industrial hemp (excluding China)—the US and Europe—are fundamentally different in their demand and consumption patterns.

Figure 6 represents the breakdown of US retail sales of industrial hemp products in 2016 provided by the Hemp Industries Association. As will be seen, the US market is considerably more highly developed than the European market. It has a more even distribution of uses and a profile of higher-value-added uses. The US's personal care market is robust due to consumer demand for natural products and chemical-free cosmetics. The use of industrial hemp as a 'super food' and medicinal product is also vital. Industrial application demand lags behind consumer consumption use, but with R&D on the crop increasing, industrial applications are expected to increase.

FIGURE 6: BREAKDOWN OF INDUSTRIAL HEMP RETAIL SALES IN THE US, 2016



Source: Based on Hemp Industries Association (n.d.).

The largest retail market in the world, the US also accounts for 60 percent of global trade in industrial hemp products. Table 7 indicates the value and trend of imports to the US over the past five years.

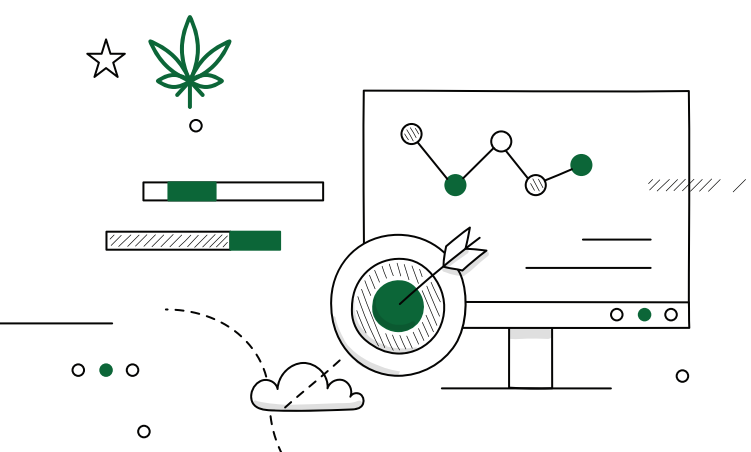


TABLE 7: US IMPORTS OF INDUSTRIAL HEMP (USD'000)

Products	2013	2014	2015	2016	2017
Seeds	26942	29326	54191	51018	42987
Oils	2264	3446	4836	6142	7603
Seedcake	6279	8159	16281	8620	11494
Fibres	78	114	292	690	780
Yarn	482	909	1497	1867	2739
Woven fabrics	1057	900	1020	744	1819
Total	37102	42854	78117	69081	67422

Source: Based on data from Hemp Industries Association (n.d.).

Seeds dominate the import basket by a substantial margin, even though values have fallen over the past three years. As will be shown later, this decline is not due to decreases in volume but to drops in international prices. Seedcake as a source of animal feed is the next largest basket item, but imports vary considerably with the availability and price of substitute products. Overall, the market has grown substantially in the past five years.

In the EU, the market is somewhat different and less sophisticated. Market volumes and values are unavailable, but data on cultivation and downstream uses are available. In the EU in 2016, 85,000 tonnes of industrial hemp were harvested, including 43,000 tonnes of hurd (woody inner portion of the stem), 25,000 tonnes of fibres, 11,500 tonnes of seeds, and 240 tonnes of leaves and flowers.

Of the hurds output, 63 percent was used in the production of animal bedding, 16 percent in construction, and 19 percent as garden mulch. Of the 25,000 tonnes of fibres, 15,000 tonnes were used in the paper and pulp industry, 7,000 tonnes as insulation material for the construction industry, and 3,000 for the production of bio-composites, predominantly for the automotive industry. Of the hemp seeds, 44 percent were used in animal feed, 43 percent for human consumption in various foods, 13 percent for human consumption as oil (food application, not CBD), and only 0.3 percent for cosmetic and personal care oil products. Only 240 tonnes of the 85,000-tonne crop in the EU were used for medicinal and therapeutic applications. This accounts for just 0.003 percent of usage, compared with 23 percent in the US.

The fact that the uses of industrial hemp are so different in the US and the EU creates the widest possible array of potential market opportunities for any country thinking of pursuing the commercial-scale cultivation of industrial hemp as an input or intermediate product in the global market. In general, the three demand drivers collectively suggest that a future industrial hemp market holds great potential and possibly new and strong growth opportunities as an alternative agricultural crop and as an input to green substitute products, medicines, and personal care products. That the EU and US markets differ substantially in their current end use of the product provides further impetus to the crop's potential in various uses, thus creating opportunities along the entire value chain. The plant's growth characteristics and its low input use suggest that it could also play an important role in developing country agriculture as a potential rotational crop for poorer farmers seeking income source diversification as part of their livelihood strategies, as well as providing valuable input for developed countries' value chains, where

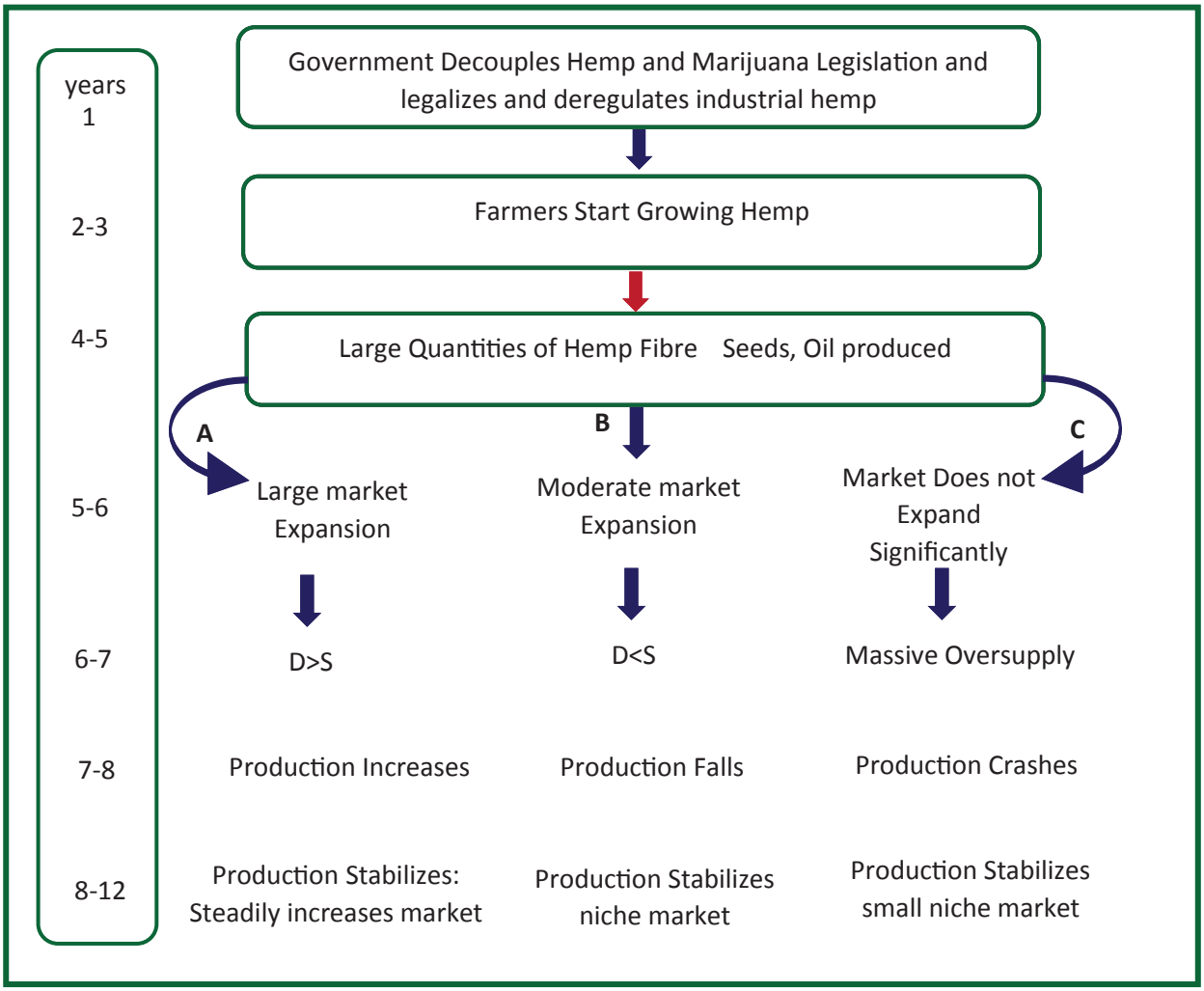
As presented in Figure 7, a novel crop takes about 12 years to become embedded in an economy (Cherney and Small, 2016). During these growth years, the balance between supply and demand is crucial. In the event of mass cultivation without the proportional increase in end-market demand, farmers will see prices tumbling. Cultivation will rapidly become commercially unviable, switching from industrial hemp to an alternative crop. On the other hand, a surge in demand with insufficient supply will lead to shortages of industrial hemp inputs, which will drive up end-market prices and decrease the attractiveness of final products. Adding to these supply and demand issues is the question of investment by processors in productive capacity. The difficulty in getting any new industry started is that a stable supply chain has not yet been fully developed; without stable end markets, the establishment of processing plants will stall. Therefore, the risks to be faced by any early movers at scale are considerable.

INDUSTRIAL HEMP VALUE CHAIN ACTORS

Stakeholders in the Industrial hemp value chain - Fibre

Industrial hemp is produced for three main products: CBD, Seed, and fibre. This gives it some unique value chain actors different from other fibre producing crops. A general framework for the CBD industrial hemp value chain is detailed in the figure below. Each key component of this value chain is described in more detail below.

FIGURE 7: DEVELOPMENT PATH OF INDUSTRIAL HEMP, A NOVEL CROP



Source: Based on Cherney and Small (2016)

Seed Suppliers and Geneticists: Seed suppliers are fundamental and often approved after meeting international standards and adhering to country regulations. In most industrial hemp-producing countries, especially in Africa, the Ministry of Health and Drug control agencies are involved in the certification process to ensure control. In Nigeria, the FMARD, NDLEA, and NAFDAC are likely to be involved in the certification of seed producers and suppliers. Seeds are sold directly to industrial hemp producers. All categories (small, medium, and large-scale producers) exist in European, American, and Asian hemp- producing countries. In Africa, however, only small-medium scale producers are common, primarily due to the controlled cultivation system.

Producers: Industrial hemp growers complete the operations from planting to harvesting. As the industry evolves, growers choose methods of operations: manual or mechanically, determined mainly by finances and business objectives. When producers are under contract to deliver dried biomass material or those who sell on the open market, they often find the need to invest in a drying solution. Drying solutions can be as simple as hanging whole or partial plants in a barn that supports air movement. Drying equipment may be as advanced as gas, modular tobacco, or hops dryers. Technology is developing fast in the industry in developing larger volume drying solutions to meet growing demands for CBD.

Larger scale drying and storage facilities are developing as producers connect with experienced companies offering more capital-intensive drying solutions. Some producers may skip the assembly and storage function entirely if they contract fresh biomass directly to processors, as some currently do in major producing countries. In Africa, growers experimenting with small acreages will want to develop confidence and obtain certifications in drying capabilities before scaling plots to meet expanded contract opportunities. Equipment manufacturers and producers continue to innovate to improve the harvest process.

Processors and Extractors: Hemp floral and leaf biomass processing for cannabinoid extraction is typically done on a small scale by vertically integrated medicinal herb companies selling their own branded products. More extractors have entered the industry recently, and the shelf space devoted to branded CBD products has become crowded. Larger extraction companies employing multiple extraction units are essential to meet the growing market needs for hemp products.

Extraction companies may buy hemp biomass from producers under contracts, bids, or online marketplaces. As a service offered to industrial hemp producers, many extractors process floral biomass into crude hemp oil, refined hemp oil (full-spectrum or broad-spectrum), CBD isolates, or white label products. Retailers sell white-label products with their branding, but a third party manufactures them. In addition, some extractors process producers' material for a share of the crude oil or final product, with share splits depending on the product delivered. Industrial hemp processing/extraction processing is the most engaging, with several activities and phases to ensure quality and completion.

Marketers: These actors are complete when they supply to the end-user – consumers. Marketers comprise wholesalers and retailers. Retailers and wholesalers are often involved in the sell industrial hemp and CBD products. In advanced producing countries, the retail landscape for hemp extract products has developed rapidly online and at small shops in strip malls.

Stakeholders in the Industrial hemp value chain - Seeds

Seed And Genetics Suppliers. Seed companies play an essential role in the industrial hemp seed value chain. Certified seeds are still a crucial considering factor when purchasing industrial hemp seeds. Growers look for seed selection guidance from genetics suppliers and companies that mandate certain varieties in their marketing contracts. When selecting a variety from seed suppliers, growers look for proven acceptable THC levels, percent germination, seed number per pound, and indications the varieties are suitable for seed production. Further considerations are shattering potential and seed quality acceptable growing conditions. A close relationship with a seed supplier and contracted hemp seed buyer is always important.

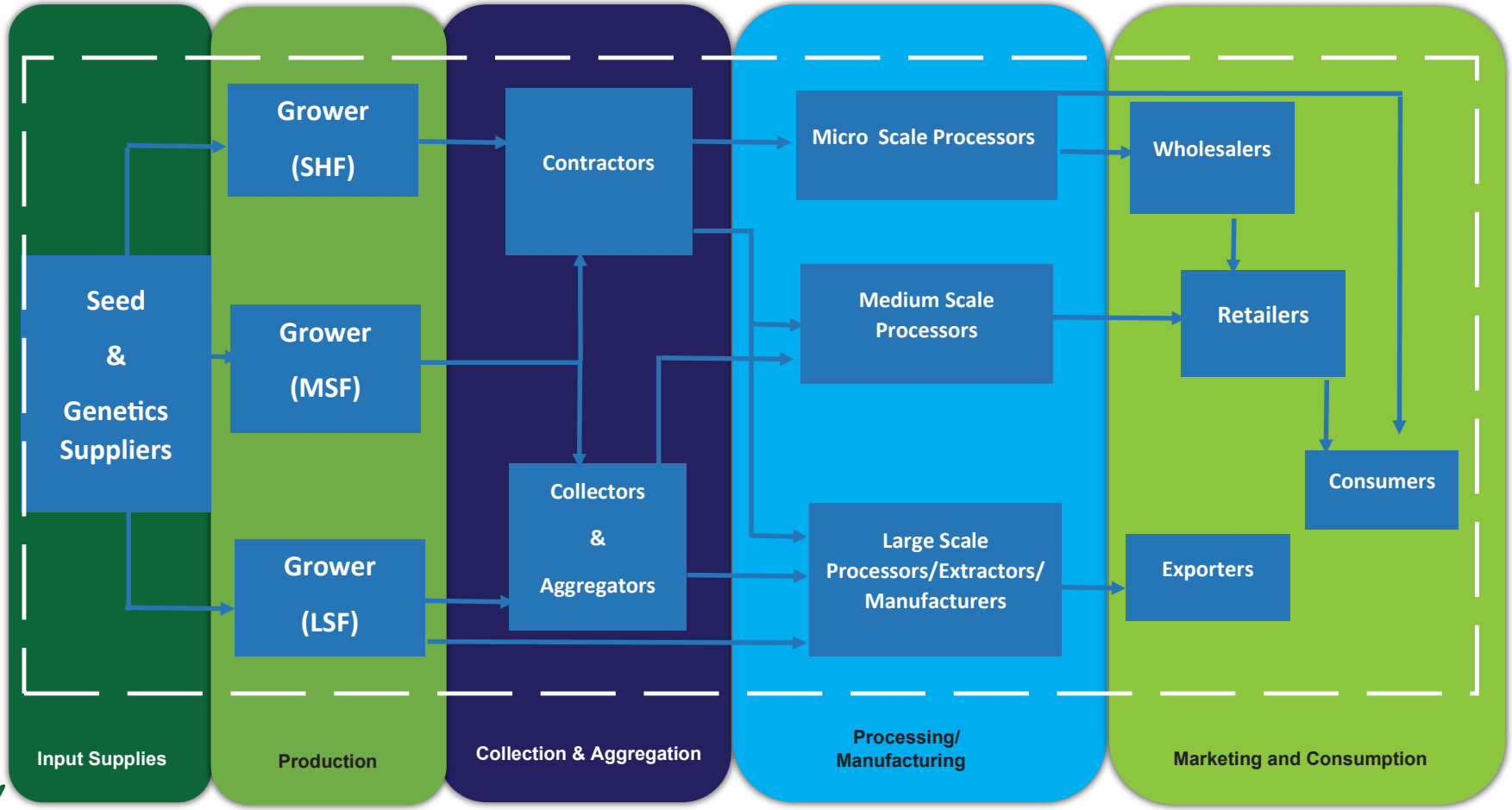
Growers. At the farm level, producing hemp for seed is similar to producing other row crops. Hence, producers' relationships with processors, seed companies, and distributors are similar. Hemp seed can be drilled or planted in tight rows. Industrial hemp for seed can be harvested with traditional combined equipment. Assembly and storage of hemp seed are necessary to ensure quality hemp seed for food- grade products. Food-grade quality control and segregation are combined for storage through hauling to final delivery.

Processing. Once the seed has been dried and cleaned, processing commonly takes one of two forms. One process is hulling, which takes the "meat" out of the shell. Larger seeds are preferred. The meat, also known as hemp hearts, is sold as a food ingredient to be eaten directly or added to various health foods. The other process is cold pressing or crushing the seed, which yields hemp seed oil and seed cake.

Hemp seed processing facilities typically contract some local hemp production acreage to ensure a supply but may buy additional seed on the open market. Processors buy delivered seed as needed throughout the year and require producers to store the seed. Successful hemp seed producers ensure to understand the food-grade quality concerns of processor contracts and meet them. Traditional harvesting, screening, air drying, and segregating hemp seed are important skill sets for processors.

Wholesalers and Retailers. In the US, hemp seed processors typically sell to wholesalers and distributors. They sell hemp seed hearts, hemp seed oil, and hemp seed protein powders as packaged products to health food distributors either as a brand or as a contracted private label.

FIGURE 8: GENERAL NATURE OF INDUSTRIAL HEMP VALUE CHAIN



Source: Author's Computation, 2022

Overview of Nigeria's fibre industry and policy

Cotton value chain in Nigeria

Cotton is the most important fibre crop in Nigeria. It is the country's most extensive fibre crop - per volume of output produced. Cotton development started in Nigeria in 1903 and can be grown in 24 States across four agroecological zones. Its fibre is the primary cost driver in the Nigerian Textile Industry, contributing 69 percent to spinning, 75 percent to weaving, and 57 percent to dyeing, printing, and finishing. Cotton has diverse uses, provides thousands of valuable products, and supports millions of jobs as it moves from field to fabric. Cotton is a source of fibre for the textile mills, edible oil for human and industrial uses, and a by-product for livestock feed. The crop offers an avenue for raising incomes and improving livelihood in rural areas with high poverty.

The main products supplied from the Cotton VC in Nigeria are:

Cotton lint. Cotton lint is the primary driver of the flow in the cotton market. Cotton lint is the soft hair around the seed called floss, which is made of cellulose that serves as a raw material in the textile industries to manufacture large proportions of adsorbent fabric for clothing as a natural textile fibre. The lint is also used to produce thread after spinning. This forms the basis of the textile and fabric industries, which depend on the mass utilization of thread to weave and make fabric and cloths (apparel). A higher concentration of Cotton lint factories resides in Nigeria's North-west and South-West regions. Over 95 percent of cotton lint used in Southern factories is supplied from the north. Zamfara state used to have 17 cotton processing industries, the highest in the country. However, only 4 of these industries are operational and operating at 10 percent capacity.

FIGURE 8: BAG OF COTTON LINT FOR SALE IN A RURAL MARKET IN KADUNA

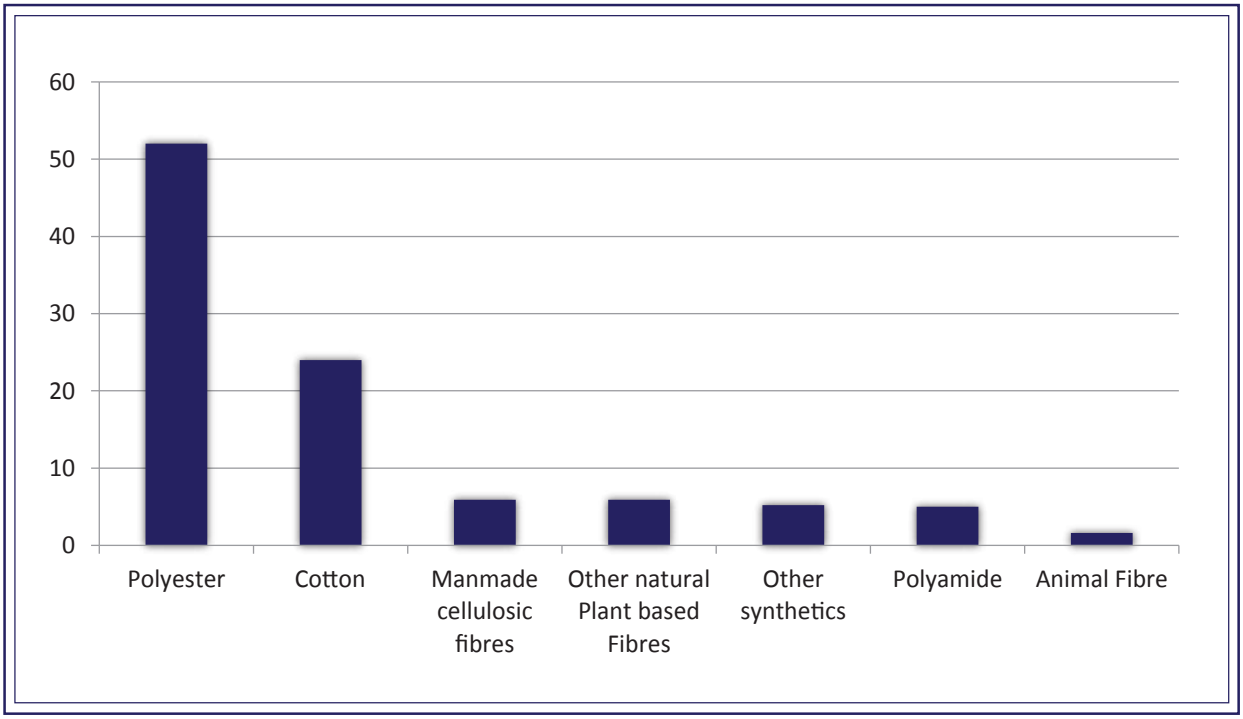
Source: Study during a visit to Kaduna (2022)

Cottonseed. The cottonseed market consists of the processors that transform it into raw oil and cake. The major drivers for the Cottonseed market are demand in food processing and other industrial processes, growing awareness about the health benefits, and low prices of cottonseed oil. The global cottonseed oil market is expected to grow by 2-4 percent CAGR from 2020 to 2025. The oil is important for human consumption; it is mainly processed in food industries for salad oils, cooking oil, and margarine or shortening for baked goods, cake icings, and as a substitute for other edible oil sources. The cottonseed cake is a by-product of oil extraction from cotton seeds. A protein-rich feed, cottonseed meal is a common source of protein for ruminants, and they are used as source of protein for ruminants, and they are used as a partial substitute for soybean meal. The market for cottonseed in Nigeria has been spurred by increased awareness of its nutrient-rich nature and low- cost price

Cotton lint and seed exports. The bulk of the Cotton, exported from Nigeria originates from the Northern states. Medium-scale cotton trading companies dominate the trade, and the centre is in the Kano State, with the Dawanau market being the biggest physical commodity trading market in West Africa. Top export destinations of Cotton from Nigeria include Pakistan with a share of 65 percent, followed by Bangladesh and Vietnam with 19.6 and 3.81 percent shares, respectively.

Figure 9 shows the dominance of synthetic fibre in the textile industry in Nigeria. Synthetic fibre accounts for almost 62 percent of the textile fibre used in Nigeria. Polyester alone has a market share of 52 percent, while polyamide and other synthetics account for 5 and 5.2 percent, respectively. Cotton is the most important natural fibre, accounting for 24.2 percent. Changing petroleum into polyester is a long, toxic, nasty process that leads to environmental externalities and causes debilitating health problems affecting consumers and factory workers.

FIGURE 9: FIBRE TYPES CONSUMED BY INDUSTRIES IN NIGERIA ('000 TONS)



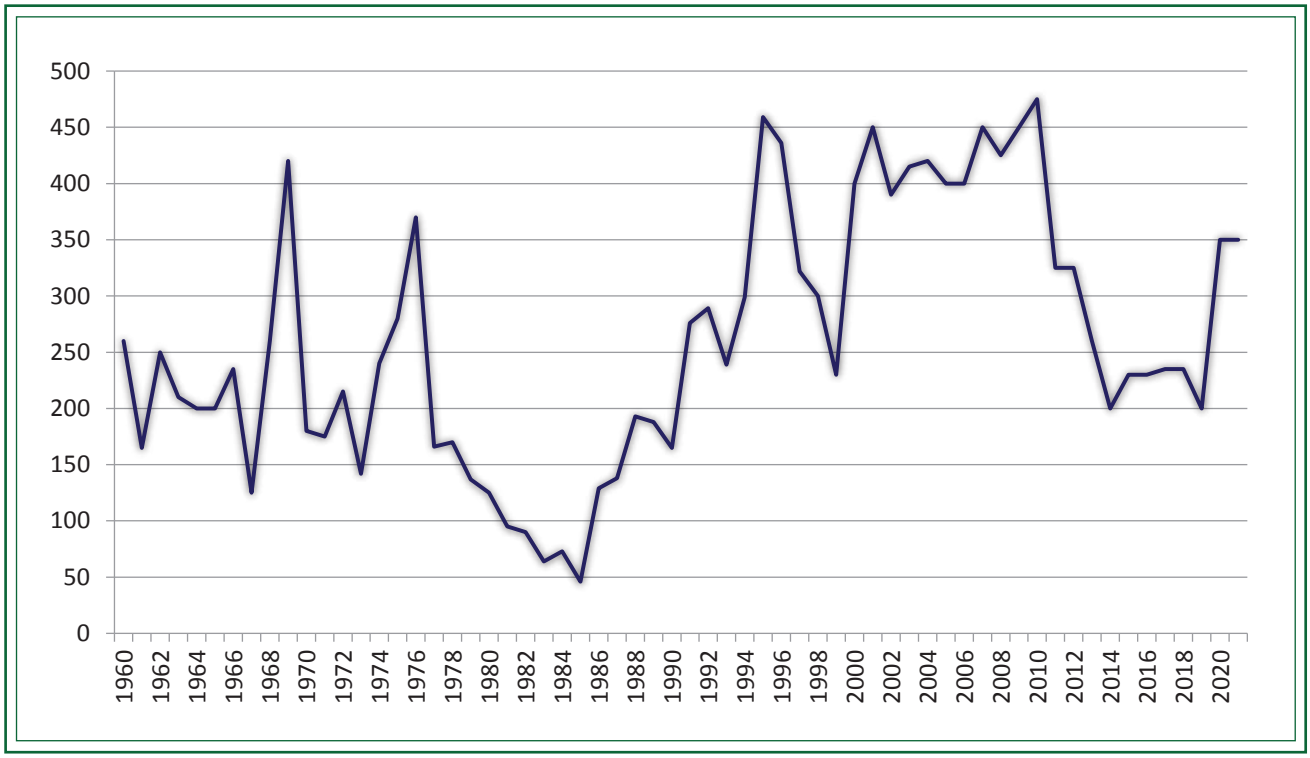
Source: Statista (2022)

Way forward for the fibre value chain

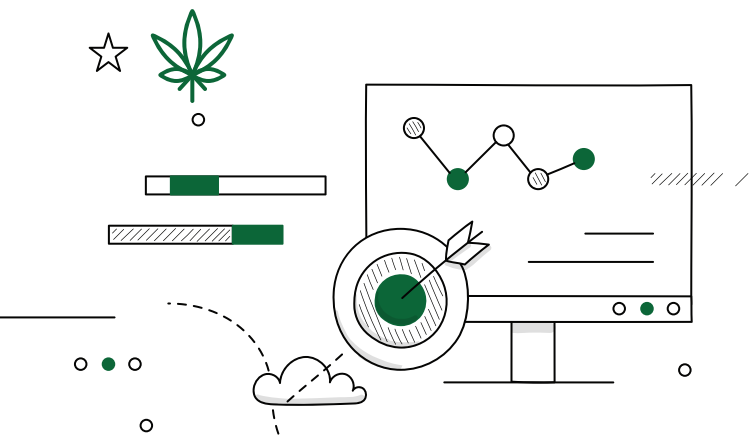
For decades cotton production has been a driving force for economic development in Nigeria. The neglect of the agricultural sector during the oil boom years (1970 to 1980s) directly impacted the cotton sector. In recent years, the cotton sector has slackened due to poor management and reduced production of both lint and seed. Nigeria, Africa's leading cotton producer and 12th largest in the world, will likely account for a paltry 20.29 percent of Africa's cotton production by 2029. The country's share of Africa's cotton production by the end of 2020 stood at 27.89 percent. Compared with projected Africa's cotton production share in 2029 is expected to decline by about 7.60 percent.

Cotton Production is concentrated in the northern states, where the average land under cotton cultivation is much bigger than in the country's south. The main feature of Nigerian cotton cultivation is that peasant farmers are 80 percent of total production under rain-fed conditions with simple tools and animal-drawn implements. Cotton in Nigeria has strong linkages with the domestic industries that consume up to 50 percent of the total production. At the same time, the remaining is exported to the EU, China, South Korea, and Taiwan.

FIGURE 10: NIGERIA COTTON PRODUCTION – 1961-2020 ('000 TONS)



Source: Indexmundi.com (2021)



According to Institute for Agricultural Research (IAR), the contribution of Cotton to Nigeria's gross domestic product (GDP) has dropped from 25 percent to 0.4 percent in the last two decades. It had a well- developed textile industry until the 1980s and was one of the world's most refined and vibrant industries. At its peak in the 1980s, the industry provided about 500,000 direct jobs with well over 250 functional factories. The industry started to decline after 2000, followed by closures of the major factories due to operational difficulties.

It is important to note that Cotton output growth in the country has been rather erratic, as shown in Figure 11. There are almost as many positive rates of growth recorded over the period (14) as negative rates (12). The supply uncertainty created by this situation affects industrial off-takers, especially the textile industry with many subsectors that depend on it. The Federal government has gotten wind of the deficit and is designing programmes and interventions and drawing policies to promote the cotton industry.

The Central Bank of Nigeria is keen on promoting the Cotton industry through numerous programs. A slight growth of production output in 2020 has shown a promising side of the Cotton industry in Nigeria. The Bank has been working with the National Cotton Association of Nigeria (NACOTAN). They have promised to deliver 350,000 metric tonnes of Cotton from their members alone in the following years.

[1]OECD-FAO Agricultural Outlook 2020 Report

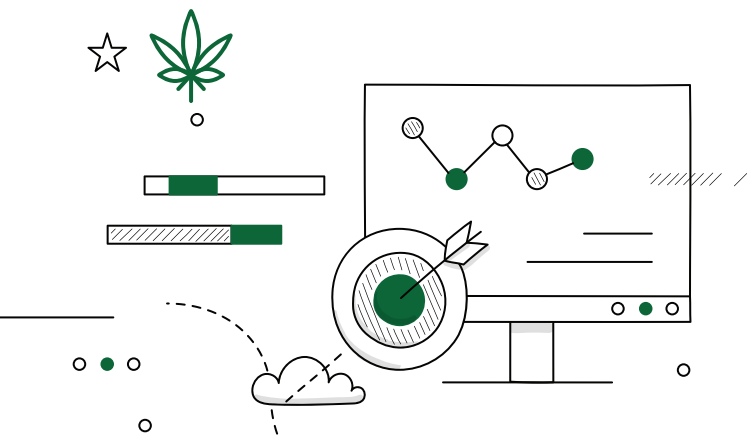
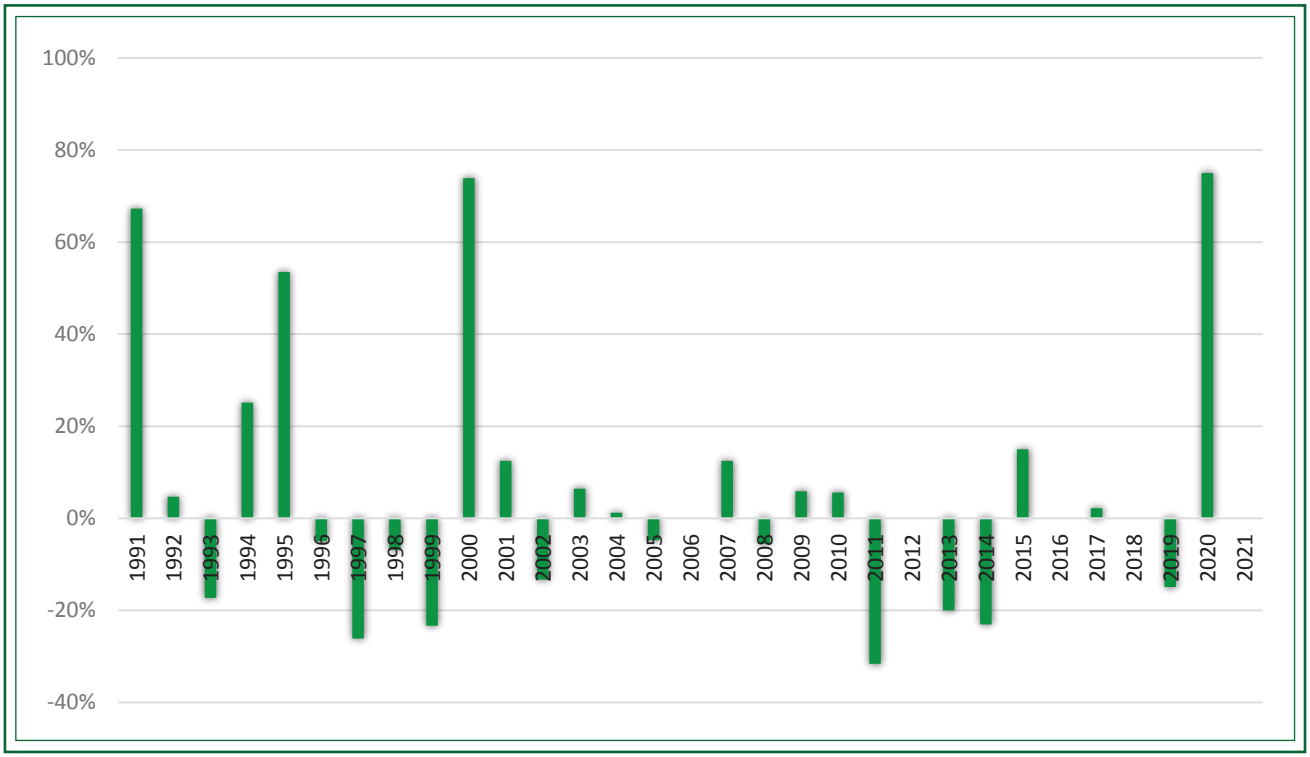


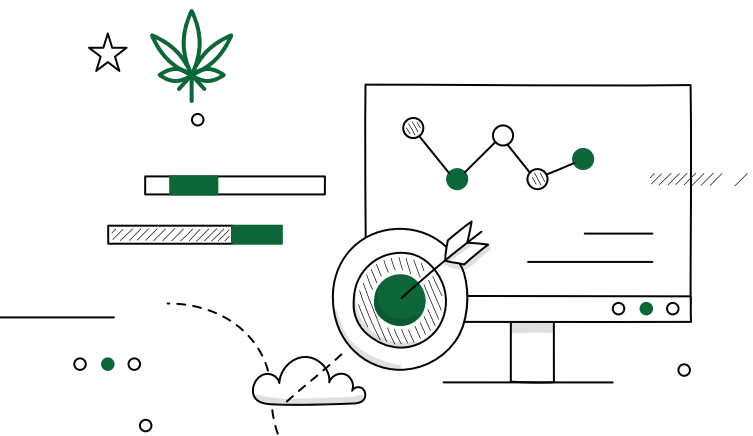
FIGURE 11: GROWTH RATES (%) IN COTTON OUTPUT IN NIGERIA (1991-2020)



Source: NAERLS (2019)

The unsatisfactory growth in Cotton output is attributed to the close down of textile factories and low- quality key inputs. Most farmers report producing an average of 0.2 tons/Ha, significantly lower than the potential 1.5 tons/Ha. Data published by NAERLS (2020) indicate that Cotton yields remain relatively low and vary across the states, ranging from 0.19 tons/ha in Taraba 2020 to as high as 3.14 tons/ha in Kaduna. The national average yield is estimated at 0.6 tons per hectare. As noted by IAR, the current yields are still well below attainable levels of about 5 tonnes per hectare.

Shrinking local markets and low seeds available to farmers have inspired Nigeria's cotton farmers to shift to other crops, resulting in the fast slide towards extinction, as shown in Figure 11. During the consultations, about 70 percent of the Cotton farmers in the north express willingness to allocate one- third of their Cotton farms to Industrial hemp and Kenaf production. Likewise, farmers in the south who cultivate relatively smaller areas indicate intent to convert 100 percent from Cotton to Industrial hemp and Kenaf. However, the switching is conditioned on some factors, including the availability of forward contracting arrangements with clear and transparent terms, plans for continuous sensitization and capacity building on good agronomic practices, and timely access to quality inputs at affordable prices.



Farmers' switching conditions and contract arrangements for fibre crops.

Evidence from our consultation in Nigeria shows that the production of novel fibre crops, such as industrial hemp and Kenaf, centered around a limited number of processing plants or contracting companies. This is because many specialty or novel crops often have no cash or "spot" market and are only grown by growers who have contracts formal or informal - with processing companies. Also, studies indicate that cultivating a novel crop without a contracted buyer can be financially risky if no established alternative cash market exists. Producers selling their commodity into a thin market can be disadvantaged by a lack of price transparency for decision-making and risk reduction and a lack of alternative buyers. Few contract arrangements described in the literature for industrial hemp are as follows:

TABLE 8: CONTRACT ARRANGEMENT OPTIONS FOR FIBRE CROPS

Arrangement	Offer	Yield outcome
Contract selling	i. Off-taker agrees to buy ii. No support services	Lower
Contract buying	i. Off-taker agrees to buy ii. Limited support services – seeds, some extension	Medium
Integrated product system	i. Off-taker agrees to buy ii. Complete support services –seeds, fertilizer, extension, funds, transportation, etc.	Higher

Source: Moyer-Lee, 2013

Forward Contracting Arrangement. This depicts a binding contract agreement to buy or sell industrial hemp products and bi-products at a specific price on a specified date in the future. These types of contracts when properly practiced, have the potentials to lock in a specific price to avoid volatility in pricing of farm inputs and output. The aggregators, as buying partners buy a forward contract and enter into a long position, and the farmers, as selling partners in a forward contract enter into a short position. If the price of the underlying product increases, the long position benefits. If the underlying product price decreases, the short position benefits. Clarity and transparency are key in ensuring the success of any forward contracting agreement between industrial hemp farmers, aggregators or and marketers.

The forward contract agreement has four main components to consider for sustained growth. These includes the following:

Product: This is the underlying product that is specified in the contract. The quantity of the agreed product must be clearly stated.

Expiration Date: The contract will need an end date when the agreement is settled and the product is delivered and the deliverer is paid.

Quantity: This is the size of the contract, and will give the specific amount in units of the product being bought and sold.

Price: The price that will be paid on the maturation and or expiration date must also be specified. This will also include the currency that payment will be rendered in.

The essence for forward contracts is mainly to hedge against potential product losses. It enables the participants to lock in a price in the future and guaranteed price can be very important, especially for novel crops such as Industrial hemp that commonly experience significant volatility in prices.

Continuous Sensitization and Capacity Building for Industrial hemp Farmers: There is really no over emphasizing the importance of continuous capacity building, the process of developing and strengthening the skills, instincts, resources and ability that farmers need for them to survive, adapt and thrive in the fast-changing world of technology through appropriate knowledge, skills, system, attitude and resources that will enable farmers especially the women farmer to be effective and efficient in processing of their farm produce.

The different categories of industrial hemp farmers, but specially the smallholder farmers and processors require proper and continuous training to address production and processing problems as well as meet the needs of potential domestic and export markets. The trainings can streamline farmers to focus on industrial hemp best agronomic practices for best quality and quantity outputs. Many industrial hemp smallholder farmers do not have adequate knowledge, skills and experiences required to participate and benefit from the whole agricultural value chain. Agricultural institutions such as the NAERLS, IAR&T, NASC and other relative capacity building private and public agencies can provide relevant training to farmers.

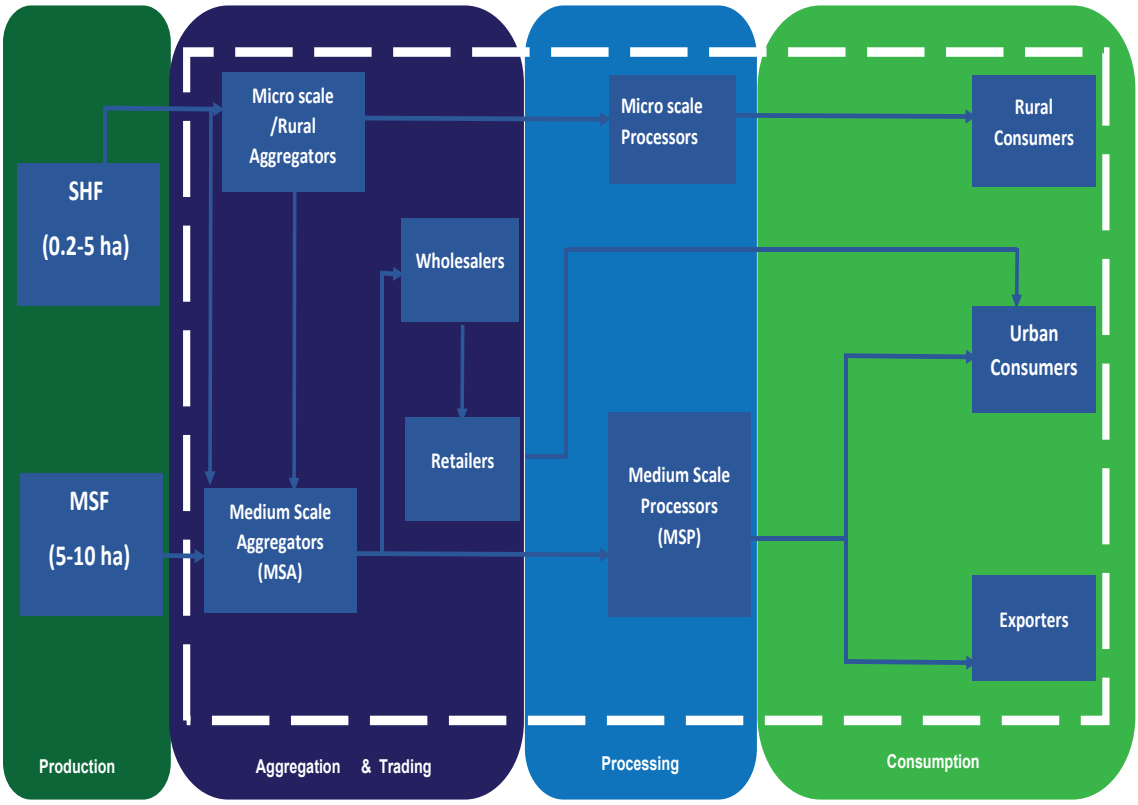
Industrial hemp Farmers' Access to Farming Inputs: Access and affordability of inputs is equally as important as the availability of and accessibility to output markets. Private sector input supplies have proven, in other crop value chains, to have effective models to deliver sustainable results in ensuring continuous access to inputs for farmers. It is expedient to note that private and public sector collaboration in ensuring farmers' access to affordable quality input is imperative for a strategic increase in the productivity and sustainable income of industrial hemp farmers.

Industrial hemp value chain in Nigeria

Nigeria's industrial hemp value chain is characterized by small- and medium-scale farmer-based production systems. This forest-based production system involves farming households that cultivate around 1 to 10 hectares of farmland, usually in plots and distributed in clusters. Industrial hemp currently has a relatively simple value chain from production to consumption. The ban on the cultivation and use of cannabis has also negatively impacted the cultivation of industrial hemp in the country. Due to its illegal operations, a tight niche and network of actors exist throughout the chain that helps maintain their covert operations. The farmers produce industrial hemp for seeds and leaves. Rural aggregators and processors supply local markets, and rural consumers with the industrial hemp produce. After simple processing, rural aggregators supply directly to rural consumers who consume the leaves are consumed as personal care products (e.g., local hair cream) and the seeds as tea and food - roasted or raw.

Sometimes, the rural aggregators sell to medium-scale aggregators, who supply medium-scale processors or supply directly to wholesalers. Retailers sell the seeds and leaves in 25kg bundles (leaves) and 1kg small packs (seeds) to urban consumers. In case medium-scale aggregators supply medium-scale processors, the partially processed leaves and seeds are either sold directly to urban consumers or sold to exporters who package them for distribution to the regional markets in the Benin Republic and the Cote d' Ivoire.

FIGURE 12: INDUSTRIAL HEMP VALUE CHAIN IN NIGERIA



Source: Authors Computation, 2022

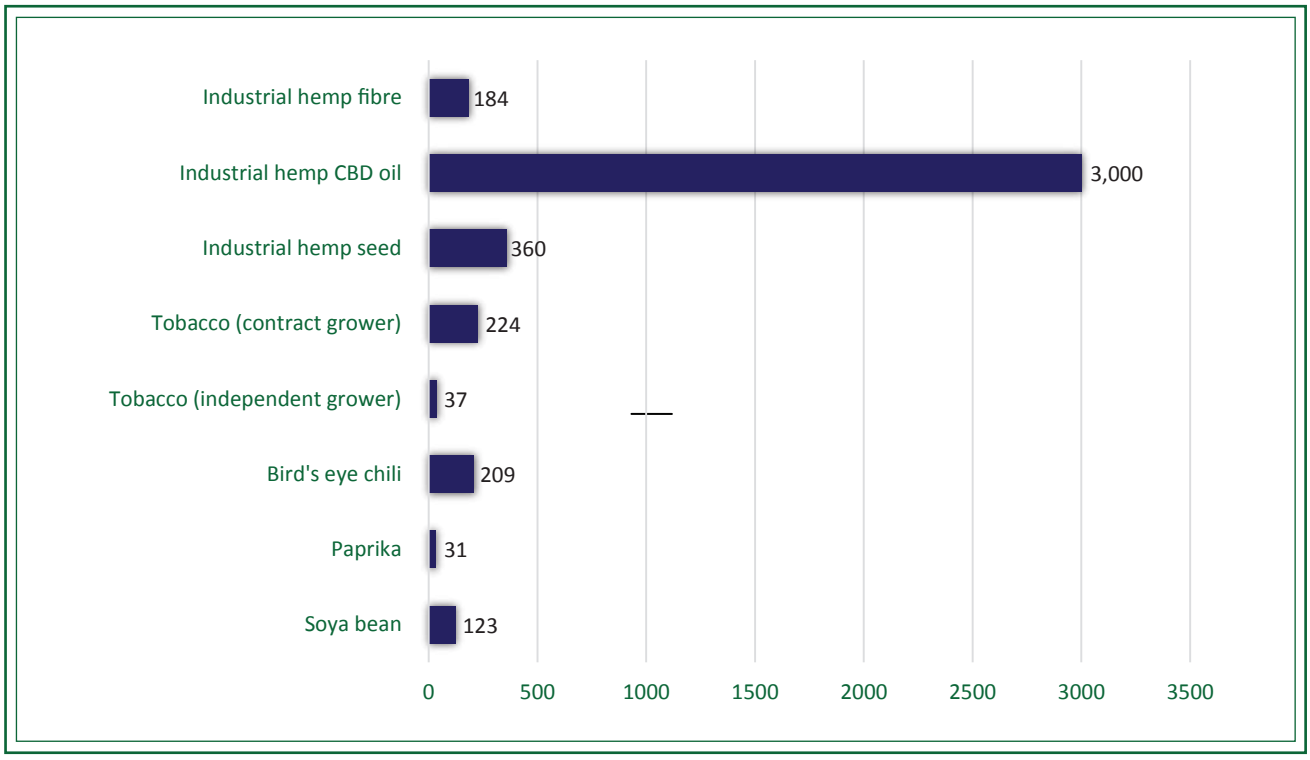
Potential for establishing an industrial hemp value chain in Nigeria

Global data and information on industrial sector and production capacity are hard to find. Nigeria has capacity and capabilities in almost all activities related to potential industrial hemp end uses. However, due to restrictive regulations, quantifying or even gauging demand is difficult, given a lack of official data and the limited current product offering. Nevertheless, we consider the potential for developing an industrial hemp value chain in Nigeria, highlighting the upstream value addition and downstream capabilities and areas that require further support and upgrade.

Suitable for Production in Most Nigeria's Agroecology: Researchers at IAR&T confirmed that industrial hemp was successfully germinated and cultivated to harvest using limited inputs and rain-fed growing techniques during on-farm trials using certified imported seeds. Thus, industrial hemp crop cultivation has proved successful from an agronomical perspective. Also, based on what has emerged, there is technical know-how and experience of cotton and Kenaf producers in rural Nigeria, which we believe will be significantly valuable in cultivating industrial hemp.

Higher Profit Margin: Depending on the end-use chosen, the margins per acre possible with this alternative rotational crop suggest that diversification into industrial hemp would be commercially viable for smallholders. This is particularly true in light of the likely pressure on cotton prices caused by decreases in demand. The market demand for some of these end-use fibre products is currently a niche. Studies attribute this to limited awareness of uses, supply, and marketing. Although this need not be an industry development constraint, as Nigeria could export value-added products. The final estimations of the margin or yield per hectare are yet to be made public. However, the assessment looks positive using estimates from the case studies in developed markets and calculated margins for Malawi's top four cash crops cited in Drope et al. (2016).

FIGURE 13: CASH CROP MARGINS PER ACRE (USD)



Source: Drope et al. (2016); Fortenbery (2014).

For decades cotton production has been a driving force for economic development in Nigeria. The neglect of the agricultural sector during the oil boom years (1970 to 1980s) directly impacted the cotton sector. In recent years, the cotton sector has slackened due to poor management and reduced production of both lint and seed. Nigeria, Africa's leading cotton producer and 12th largest in the world, will likely account for a paltry 20.29 percent of Africa's cotton production by 2029. The country's share of Africa's cotton production by the end of 2020 stood at 27.89 percent. Compared with projected Africa's cotton production share in 2029 is expected to decline by about 7.60 percent.

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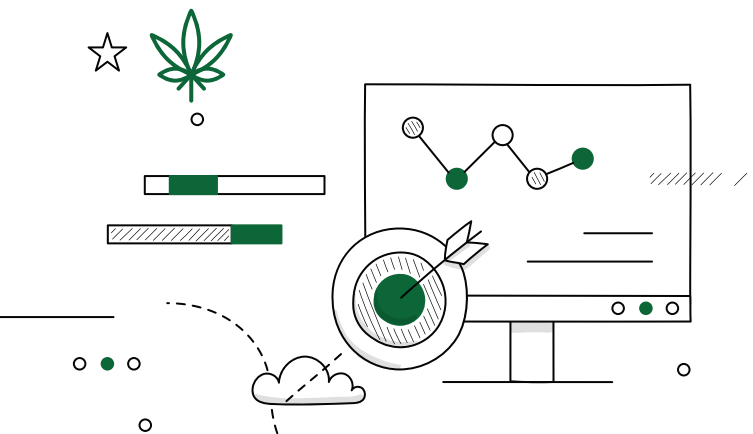


Industrial hemp potentially provides a highly profitable alternative cash crop when grown for the production of CBD oil or hemp seed or as a dual crop for seed and oil. However, it is worth noting that the seed market has not been fully identified and appreciated as a significant market opportunity in Africa. This is a severe oversight given current international markets and traded volumes. Therefore, with the interest of the FG in the alternative sustainable fibre space and the active collaboration with producers' associations and the private sector, national research institutes such as IAR&T and RMRC have the framework to respond to the good agricultural practices (GAP), good storage practices, and good harvesting practices required by international markets for the production of a foodstuff for human consumption.

Lower Environmental Impact: The credentials of industrial hemp in terms of required inputs and effects on soil suggest that, environmentally, the crop would be superior to cotton. However, given the structure and history of smallholder agriculture in Nigeria, a shift to industrial hemp as an agricultural commodity would need to occur within a system of value chain upgrading and support, as well as contract buying or offtake agreements.

Processing Capacity and Technology: Downstream processing capability and capacity in Nigeria would vary across different uses of industrial hemp. Fortunately, capacity and capabilities are highest in the current niche markets of CBD oil extraction and seed production, which exhibit the highest levels of demand and are viewed as having the most significant potential to grow. Private investors and the FG are not starting from scratch even though they will be significantly upgraded, especially for valuable end-use products. Due to a decline in the demand for cotton, several moribund processing facilities such as cotton seed oil plants have been converted and upgraded to produce other vegetable oils. There is no reason not to assume that a similar process could be undertaken for industrial hemp.

- **Many Textile Plants are old and not set up to work with natural fibres:** However, FG's agencies and research institutes (e.g., IAR&T) are already mandated to undertake R&D in producing, processing, and alternative uses of novel fibre crops, such as Kenaf. Experts consulted at IAR&T suggest that existing growing and harvesting techniques and knowledge for Cotton and Kenaf are transferable and applicable to industrial hemp. Also, they have been undertaking R&D to adapt cotton-based processing equipment for processing kenaf, natural hemp, and others.

  Nigeria's downstream processing capacity and capabilities are weakest in textile manufacture. This sector has been negatively affected by cheap import leakages and a failure to produce cost-competitive output for export. The import to domestic production ratio has been high, and sectoral real gross domestic fixed investment (GDFI) has been declining consistently for years. In 1990, GDFI contracted by 39 percent to 53 percent, and in 2013 and 2020, it was 14 percent and 29 percent, respectively. Leakages and low demand for domestically produced items have resulted in low capacity utilization rates, implying that the spare capacity exists.

- **Only a Few Food Companies in Nigeria meet GMP,** the international standard for preparing foods for human consumption. Meeting these international standards has been a severe challenge for many African countries. The resources necessary for industrial hemp farmers to meet GAP standards if the crop were to be used for human food preparations and oil consumption is enormous. Hence, short- term practical and commercially feasible solutions for developing Nigeria's industrial hemp sector would be for external contract buyers to purchase unprocessed industrial hemp and export it for further secondary value addition to various uses. As demand grows in Nigeria, we could attract the value-adding activities back into the domestic market. Still, interviews with some experts in the food industry suggested that if industrial hemp is legalised and the products became mainstream, there would be no problem producing seed, oil, flours, pastes, and meals from the inputs supplied postharvest at a commercial scale.

- **There is also the Issue of CBD Oil:** Literature has shown that marijuana-derived CBD oil will always be preferred to industrial hemp-derived CBD oil by consumers, and it will always be more commercially viable because of the different levels of concentration of CBD compounds in the plants. The demand for CBD oil from industrial hemp in these markets is relatively weak. If marijuana legislation and regulation are relaxed – following the global trend - demand for industrial hemp CBD oil will decline significantly. However, some suppliers may exploit the price differentials for gains due to the quality differences between marijuana-based and industrial hemp-based CBO oil. Besides, there could be heterogeneity in preference for the oil vis-à-vis the retail prices. A large-scale investment will be forthcoming to produce this product if the likely short-term market extend and a price bubble peaks with increased awareness and the legalisation of marijuana.

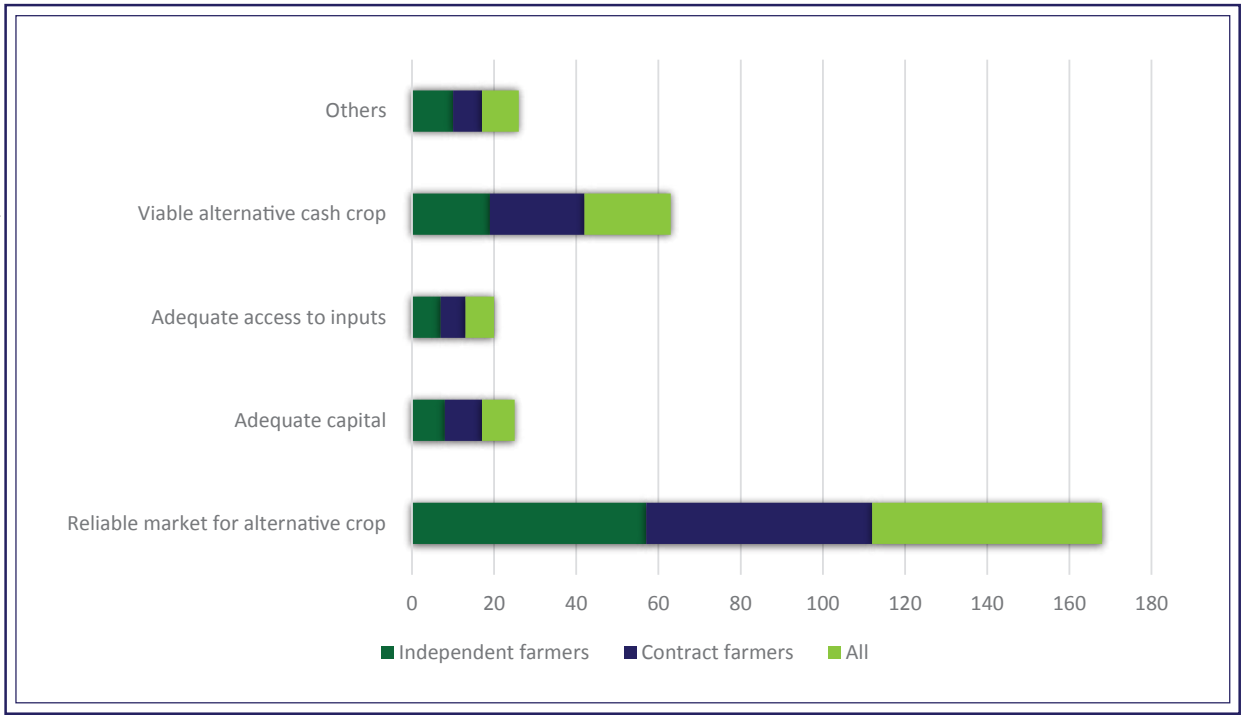
- The greatest opportunity for Nigeria industrial structure relates to producing industrial hemp-based nutraceuticals, dietary supplements, and tablets. This opportunity exists because of its biodiversity, Nigeria has always had a large number of herbal, homeopathic, and **natural plant-based personal care products** and therapy producers that are very popular in region. They cater of niche market. However, with legalisation and increase awareness on the benefits, these producers plan to invest substantially in R&D and new product development and sell into niche markets and glogally.

- Finally, concerning other **innovative uses of industrial hemp (e.g., as an alternative insulation material, in bio-composites, and organic paint production),** it is hard to assess Nigeria's capacity to produce such goods given that not even niche markets exist. During our consultation at IAR&T, we were shown several bio-composite materials made from Kenaf and Sisal, and from talking to the experts operating the natural fibres research division, it appears that substantial R&D is being carried out on alternative uses and processing technologies. If industrial hemp became a mainstream agricultural commodity with mainstream market acceptance and demand, Nigeria would already have a core knowledge base and be well-positioned to take advantage of several new opportunities. Work on bio-composites is particularly advanced. These opportunities require a reliable supply chain of cost- competitive raw and semi-processed inputs and feedstock.

Existence of farmer input support programmes that aids diversification. Anchor Borrower Programme (ABP) is a support programme introduced by the FG and made available for different crops to facilitate cash crop diversification. These policies and programmes bode well for potential diversification into industrial hemp, as there is, in principle, a tried and tested mechanism to support a shift into alternative crops. Support programming allows such a shift using existing outreach, extension service, and input subsidization programming. Also, since industrial hemp requires relatively lower inputs than cotton, it is a cheaper support alternative. It would decrease the absolute and relative resources required through the ABP. Similarly, because industrial hemp can be successfully grown using natural rainfall, the limited financial resources earmarked for irrigation for small farms could be focused on maize production and improve food security.

Willingness to switch from cotton to alternative fibre crops. During our consultations for this study, almost 70 percent of cotton farmers express the desire to allocate one-third of their cotton farms to alternative fibre crops such as industrial hemp production. Producers' willingness to switch is based on the availability of offtake contract arrangements and capacity building on good agronomic practices. While smallholders tolerate some price variation, the risk of total crop failure or failure to find a buyer is unacceptable. This finding is consistent with the study by Drope et al. (2016) in Malawi, who asked smallholder tobacco farmers what switching from tobacco to an alternative cash crop such as industrial hemp would take. The responses are shown in Figure 14.

FIGURE 14: DRIVERS OF PRODUCERS' DECISION TO SWITCH TO CASH CROPS (PERCENT)



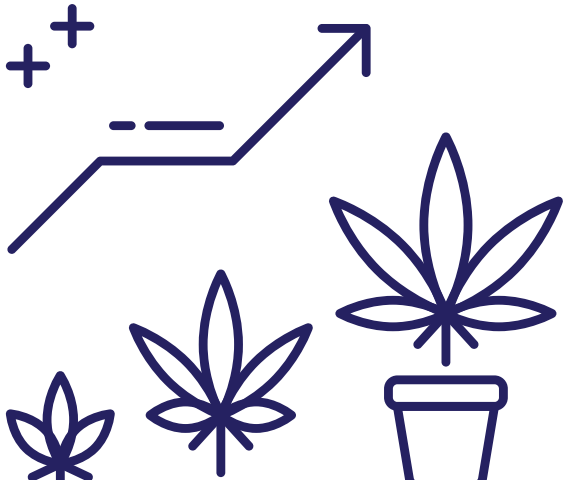
Source: author's construction based on Drope et al. (2016).

Even in relatively developed markets in Canada, the US, and Australia, industrial hemp farmers will establish upfront purchase undertakings or offtake agreements before being granted a licence due to the thinness of existing markets. Likewise, due to the existing low levels of capital intensity and the long-term introduction of input supply packages supported by donors and the FG, adequate capital and access to inputs are not considered binding constraints to crop diversification. The Anchor Borrower Programme (ABP) is a form of offtake agreement, and the current system for cotton under ABP fits well with existing international market practice and experience. This business model is transferable, and a similar process could be undertaken for industrial hemp in Nigeria.

EMERGING CONCLUSION AND FORWARD ISSUES

This study involves extensive review of extant literature, reports, relevant documents, and online database on industrial hemp. Also reviewed are publications and reports (see references). The desk review entails an analysis of market reports, policy documents, technical reports, journals, newspaper articles, and other relevant documents. The review helps identify the stakeholders, market dynamics, prospects, challenges, solutions, and entry points for Industrial Hemp in Nigeria. Moreso, the task involved a thorough assessment of the local, regional, and global VCs of Kenaf and Industrial Hemp. Additional information was collected from relevant government ministries, departments, and agencies (MDAs), including research and development institutes, and academic institutions.

We find that there is an undeniable opportunity for industrial hemp to become a niche product and for a future industrial hemp value chain Nigeria to be based on servicing such a niche market. If global demand subsequently expands, early adoption and entry into the value chain will position participants in an advantageous position. Even if the market is not scaled up, the niche market opportunities will remain sustainable as a source of cash crop diversification and new product range manufacturing opportunities in the country.

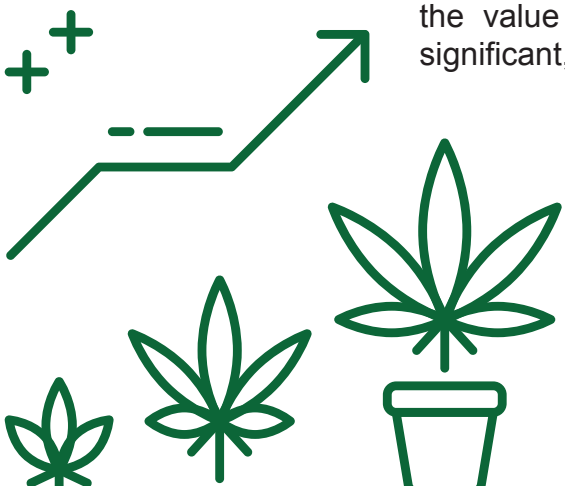


From the review, we find that the most viable and most robust demand-led niche markets for industrial hemp are currently: the production of hemp oils to be used in cosmetics and personal care products, the production of hemp seeds for human consumption as a 'super food', and the production of CBD oil for therapeutic use. Of these three, CBD oil production is likely to be the most lucrative in the short term. Although there is an important caveat that if CBD oil demand increases substantially, then naturally sourced compounds are likely to be overtaken by synthetically engineered equivalents that are cheaper to produce and more scalable. This suggests that the CBD market sourced from natural plant materials may not be sustainable in the medium to long run. However, the market for hemp as a foodstuff remains sustainable, as does the market for essential oils.

Although due to dearth in data a more extensice analyis is difficult. Nevertheless, preliminary findings from case studies in North America, Europe, Asia and Southern Africa indicate that industrial hemp would be a profitable and potentially strategic diversification. If and when the legislative constraints on cultivation are lifted, challenges will remain in implementing such a value chain. However, no challenges have been identified that would not, in principle, be solvable.

Constraints in establishing an industrial hemp value chain and way forward

The future of the industrial hemp market and its potential for growth and development are neither straightforward nor obvious. Few studies have examined the possibility of industrial hemp as an agricultural crop, exploring the issue of future demand for industrial hemp and its down-stream products and conditions necessary for it to transition from a novel crop into a mainstream crop (e.g., Cherney and Small, 2016). The authors argue that new 'miracle' crops on the market have always captured popular and agricultural circles' imaginations over the years. They indicate that novel crops typically come with agronomic, processing, conversion, economic, or social issues that prevent them from achieving their potential. Among the several possible constraints to the value chain, we identify the following four factors as the most significant, these are:



Inadequate Processing Capacity and Technology:

As previously discussed, due to the near absence of commercial-scale cultivation of industrial hemp globally, investment in R&D and processing-related technology have been limited. Inadequate processing capacity has stymied market demand making industrial hemp still a novel, niche-market crop. Studies show that even if hemp cultivation volumes increased substantially to decrease its price as an input feedstock, the current state of hemp processing technology would render any hemp-based products uncompetitive in the marketplace, given the existing alternatives. Thus, explaining why no multinational companies have become active in the market.

Logistics Challenges due to Bulkiness:

Industrial hemp plants are enormously bulky, and transport costs could undermine margins down the value chain. Production facilities must be located close to land under cultivation to mitigate this problem. However, studies indicate that such a scenario seems unlikely given current economies' tendency towards agglomeration and manufacturing clusters. Possible pest and disease incidence. Agronomic risk is another constraining factor. As industrial hemp becomes more widely cultivated, its rate of pest and disease incidence will likely increase, resulting in increased application of pesticides, which will drive up input costs and nullify some of the crop's green credentials.

Absence of up-to-date data for Decision-Making:

It is difficult to accurately assess global and individual country demand and demand patterns for industrial hemp over time because of a lack of official data. The few case studies on commercial viability of industrial hemp conclude that uncertainty and risk still characterise the value chain and that substantially more research and data are required to allow investors make informed decisions. The consensus among the authors is that, yes, an industrial hemp market has potential but that its potential is less than is suggested by the 'green revolution' hype in the press. Also, the chain is more challenging than generally envisaged in terms of processing capacity and costs. They found that growing hemp for seed and CBD oil is the most lucrative and likely commercially successful activity and that cultivar breeding for these two uses will become more profitable over time. However, the industrial hemp market's future depends on the type(s) of demand that will prevail and the crop's future sustainability. Table 7 shows three broad scenarios and timeframes proposed by Cherney and Small (2016) to estimate the probable paths for establishing a viable industrial value chain.

Poor Quality Seeds and Cultivars.

The quality improved seeds are difficult access and expensive. If industrial hemp became a mainstream agricultural crop rather than a drug, more productive cultivars and cultivars fit for a dual crop purpose would need to be developed at scale. Moreso, a better understanding of input requirements and crop management would need to be developed to support scaled-up cultivation commercially viable.

Shortage of Processing Capacity.

Concerning processing capacity and capabilities, while some processing knowledge, know-how, and capital equipment can be brought to bear and repurposed for developing a novel crop, processing capacity and development are limiting factors in many instances. This is abundantly true of industrial hemp. Many countries are limiting licences for industrial hemp cultivation due to the shortage of processing capacity.

Near Absence Investment in R&D.

They also note that private companies, primarily multinational corporations, fail to invest in the sector, implying that the crop will likely remain a novel, niche-market crop soon. Other authors argue that as R&D occurs in the sector and harvesting and processing capital equipment and production processes improve, the profitability of the crop will increase, allowing additional market expansion.

The Market is Undeveloped and Strongly Influence by Cocial and Political Concerns.

The most important single contributor to the success or failure of a novel crop is market demand. The present research suggests that current global demand is sufficient only to support industrial hemp as a niche market. This demand is dominated by drivers related to the healthy food properties of the product and its therapeutic uses as oil and input in personal care and cosmetics. There appears to be a shared view that if industrial hemp becomes a mainstream, large-scale, commercially cultivated crop globally, demand for environmentally friendly alternative consumer and industrial goods would need to grow substantially. Currently, demand for non-fossil fuel renewables and environmentally friendly alternative products is sufficiently patchy, fragmented, and variable. The industrial hemp and downstream processed products market is a niche, with thin markets and low traded volumes. Whether this will change is hard to predict.

Sources of Caution in the Demand for Industrial Hemp

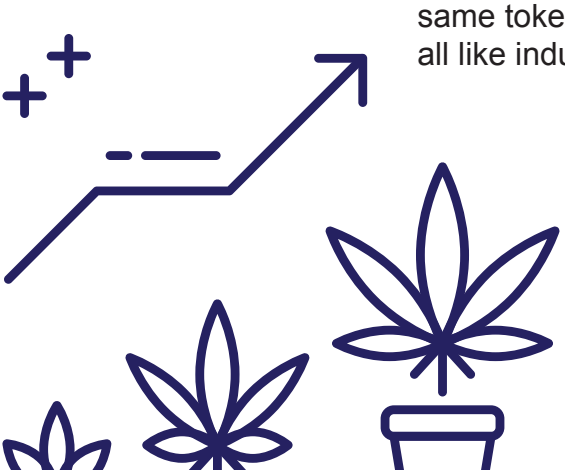
Despite this potential, two cross-cutting themes or cautions appear in most of the demand-side literature.

- **Given existing legislation, industrial hemp's commercial viability is untested and unknown.**

  The first is a lot of hype around industrial hemp as a 'saviour' crop: the green solution to industrial-age manufacturing, the renewable energy alternative, or the marvel therapeutic and medicinal plant. Whether this hype will translate into commercially viable economic opportunities and dynamic markets is unknown and untested in the main, given existing legislation. At this point, market realities remain sufficiently constrained that future investment and commercial behavioral change is not yet visible to any marked degree, and all that can be argued is that industrial hemp is not the key to our green future (Cherney and Small 2016) but its potential is sufficient to merit further investigation.

- **Limited research and development exist on the potential of industrial hemp.**

  The second cross-cutting issue raised in all the demand-driver literature is that because of 50 years of prohibition, there has been very little research and development related to industrial hemp cultivation, harvesting, production, or final good development. The lack of technological development substantially impacts the commercial viability of all value chain stages. Existing combined harvesting technology is inappropriate for cutting hemp plants at the harvesting stage. In the processing stage, the costs of processing hemp fibres are much higher than cotton fibres because of the antiquated spinning technology available in hemp production facilities. This calls for more industrial hemp to be made available for scientific study and experimentation, which will naturally occur as market demand for green substitutes and natural products increases, especially in developed countries. What the literature suggests is that what may be commercially unviable at present could become profitable over time if cultivation and production costs decrease as a result of technological improvements and an increase in R&D. By the same token, the range of products and uses for industrial hemp would in all like industrial hempood expand when and if research efforts increase.



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APPENDIX

TABLE A1: LEADING INDUSTRIAL HEMP ASSOCIATIONS AND THEIR MANDATES

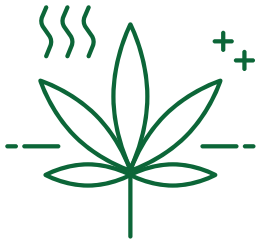
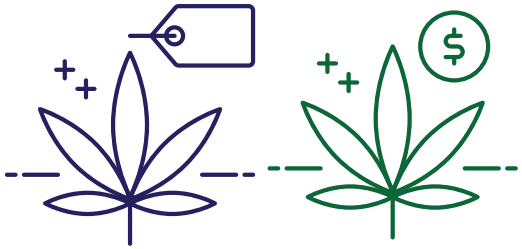
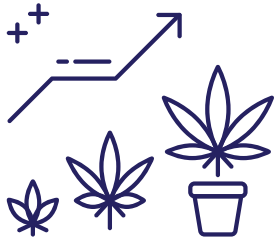
Hemp Association	Year Founded	Objectives	Composition	Milestones	Location	Scope
US Hemp Growers Association US75-250	2019	1. Keep growers up to date about legal and regulatory developments impacting their businesses. 2. Facilitate access to certified seed and/or stable genetics 3. Facilitate the connection of member growers with equipment and testing equipment dealers, and with potential buyers of their hemp.	Growers, Hemp industry affiliates, Hemp industry allied members, Hemp associate member farmers, academic and government perso students, International Hemp growers and other international hemp organizations	Created a new path forward, sparking investments in Hemp in US . >300 members	Lenexa KS, USA	Education, information sharing network, R&D, Training, advocay,
National Hemp Association US 120 – 600	2016	1. promote commerce and research of industrial hemp and it's applications. 2. operate with industry stakeholders to bolster innovation and expansion of hemp as a recognized and valued commodity for the US industry and the greater public.	Farmers , Processors, Manufacturers, Researchers Investors ***Collaborative Memberships*** 1. California Hemp Ass 2. Carribean Hemp Ass 3. Connecticut Hemp Ass 4. Hemp Alliance of Tennessee 4. Iowa Hemp Ass	Created climate action plan in 2021	Washington DC, USA	Administration, Education, Advocacy, Networking, R&D, Public Relations, Training.

			5. Indiana Hemp Ass **6.** Michigan Hemp Farmers Ass **7. Midwest Industrial Hemp Ass** **8.** Missouri Hemp Ass **9.** Kentucky Hemp Industries A**ss** **10. New Jersey Hemp Ass** **11.**N. Carolina Industrial Hemp Ass **12.** S. Carolina Hemp Growers Ass			
Global Hemp Association	1996	1. build a secure, transparent, and trusted infrastructure that encourages collaborative connection between farmers, processors, manufacturers, and markets.	Farmers , Processors, Manufacturers, Researchers Investors	1. Evaluated and propagated major varieties for cultivation 2. Supported Industry Leaders to secure funding and grants 3. Secured additional partnerships and collaboration with Universities and Educational Institutions 4. Developed standards that will elevate consistency across all verticals 5. Influenced legislative policy at	USA	Education, Advocacy, Networking, R&D, Public Relations, Training, Consulting, seed trials.

				the highest government levels. 6. Regular education events		
Pan African Hemp Association	2020	1. educate governments, civilians and companies on prospects of Hemp	Farmers , Processors, Manufacturers, Researchers, Investors		South Africa, Africa	Advocacy, consulting, Networking, Investment, R&D
European Industrial Hemp Association	2005	1. monitor EU hemp related policies 2. Influence market 3. Influence decision makers 4. Increase patient access 5. Publish research 6. Challenge current guidelines	Farmers , Processors, Manufacturers, Researchers, Investors		Duesseldorf Germany	Education, Advocacy, Networking, R&D, Public Relations, Training, Consulting, seed trials. Comprise of 25 EU countries and 12 other countries including North America
China Hemp Association	-	1. establish a technological innovation organization that combines industry, education and research. 2. achieve a cooperation system, improve the integration of industry, education and research institutes.	Producers , Processors, Manufacturers, Makerters, Researchers, Investors, Financial Institutions, Technology Service Providers	-	Qiqindustrial hempaer Shi, Heilongjiang Sheng	processing enterprises,equipment manufacturing, technological research and development, advocacy
Malawi Hemp Association	2018	1. encourage trade and discourse among hemp professionals. 2. development of the hemp industry in Malawi.	Farmers, Processors, Manufacturers, Researchers, Investors, agricultural organisations, retailers.	1. developed a close relationship with government agencies and officials for policy implementations.	Lilongwe, **Malawi**	Education, Advocacy, Networking, R&D, Public Relations, Training, Consulting, Policy Advice

				2. provided a wealth of expertise in fields ranging from agriculture to manufacturing for complete consultancy and training,		
Thai Industrial Hemp Trade Association	-	1. be a center of business cooperation, promotion, and support for its members, and to provide information to the members and those interested. 2. coordinate efforts among organizations, government agencies, and private companies in Thailand and outside to stimulate economic and industrial growth, ultimately leading to the career stability of hemp entrepreneurs in Thailand. 3. develop the group Hemp industry to have the potential and production quality to be on par with other countries able to create new industries to benefit all entrepreneurs in	Entrepreneurs, Companies, Shops, community enterprises, growers, processors, manufacturers, consumers.	-	Bangkok, Thailand	Education, Advocacy, Networking, R&D, Public Relations, Training.

		Thailand to be stable in the future.				

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