SA-TIED
Southern Africa – Towards Inclusive Economic Development

Initial considerations for the creation of an inter-regional industrial hemp value chain between Malawi and South Africa

Sandy Lowitt

SA-TIED Working Paper #92 | March 2020

UNITED NATIONS UNIVERSITY
UNU-WIDER

national treasury
Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

& evaluation
Department:
Planning, Monitoring and Evaluatio
REPUBLIC OF SOUTH AFRICA

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

SARS

TIPS

About the programme

Southern Africa –Towards Inclusive Economic Development (SA-TIED)

SA-TIED is a unique collaboration between local and international research institutes and the government of South Africa. Its primary goal is to improve the interface between research and policy by producing cutting-edge research for inclusive growth and economic transformation in the southern African region. It is hoped that the SA-TIED programme will lead to greater institutional and individual capacities, improve database management and data analysis, and provide research outputs that assist in the formulation of evidence-based economic policy.

The collaboration is between the United Nations University World Institute for Development Economics Research (UNU-WIDER), the National Treasury of South Africa, the International Food Policy Research Institute (IFPRI), the Department of Monitoring, Planning, and Evaluation, the Department of Trade and Industry, South African Revenue Services, Trade and Industrial Policy Strategies, and other universities and institutes. It is funded by the National Treasury of South Africa, the Department of Trade and Industry of South Africa, the Delegation of the European Union to South Africa, IFPRI, and UNU-WIDER through the Institute's contributions from Finland, Sweden, and the United Kingdom to its research programme.

Corresponding author: slowitt@icon.co.za

UNITED NATIONS UNIVERSITY
UNU-WIDER

WIDER Working Paper 2020/23

Initial considerations for the creation of an inter-regional industrial hemp value chain between Malawi and South Africa

Sandy Lowitt*

March 2020

United Nations University World Institute for Development Economics Research

wider.unu.edu

Abstract: Interest in industrial hemp has revived in the past 20 years. Malawi is considering legalizing the cultivation of industrial hemp as an alternative cash crop to tobacco with great potential. This study considers the potential and challenges of creating an industrial hemp value chain between South Africa and Malawi, with Malawi concentrating on upstream cultivation and South Africa on downstream value-adding activity. The research supports a finding that industrial hemp offers strong opportunities as a niche market even if mainstream demand is slow to materialize or does not materialize at all. It also shows that undertaking such an inter-regional endeavour would be considerably more complicated than initially envisaged, given the agricultural structure and operation of the Malawian economy and its smallholder farmers.

Keywords: contract buying, industrial hemp, novel crop establishment, regional value chain

JEL classification: D1, D4, O13, Q13

Acknowledgements: This working paper is part of Workstream 6 on Regional Growth and Development within the project Southern Africa—Towards Inclusive Economic Development (SA-TIED), a three-year partnership between UNU-WIDER and the South African government aimed at improving understanding of regional value chains and supporting industrialization in the Southern African Development Community (SADC) region. It is the first of two papers produced by Trade & Industrial Policy Strategies (TIPS) in Year Two of the project. TIPS acknowledges UNU-WIDER and the South African Department of Trade and Industry for their support.

---

* Trade & Industrial Policy Strategies (TIPS), Pretoria, South Africa, slowitt@icon.co.za

This study has been prepared within the UNU-WIDER project on Southern Africa—Towards Inclusive Economic Development (SA-TIED).

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-780-4

https://doi.org/10.35188/UNU-WIDER/2020/780-4

Typescript prepared by Joseph Laredo.

The United Nations University World Institute for Development Economics Research provides economic analysis and policy advice with the aim of promoting sustainable and equitable development. The Institute began operations in 1985 in Helsinki, Finland, as the first research and training centre of the United Nations University. Today it is a unique blend of think tank, research institute, and UN agency—providing a range of services from policy advice to governments as well as freely available original research.

The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland, Sweden, and the United Kingdom as well as earmarked contributions for specific projects from a variety of donors.

Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

Over the past two decades the Malawian government, donors, and scholars have (with increasing urgency) advocated for the diversification of the Malawian agricultural sector in general and, in particular, diversification away from the pariah crop of burley leaf tobacco. Given an argued pedigree in sustainability, environmental friendliness, increasing and sustainable global demand, and similarities with tobacco cultivation, industrial hemp has been considered a potential substitute (and superior) cash crop for Malawian tobacco farmers. Given also that the Malawian economy is dominated by its agricultural sector (30 per cent of gross domestic product (GDP) and 90 per cent of employment) and that it has thin domestic markets and a small and declining manufacturing sector (10 per cent of GDP and 4.5 per cent of employment), the idea has been mooted that a mutually beneficial regional value chain in industrial hemp between South Africa and Malawi could be developed.

Malawian researchers, agronomists, and politicians believe that the legalization of industrial hemp as an agricultural commodity is imminent in Malawi. It is therefore possible that Malawi could cultivate, harvest, and undertake primary processing of an industrial hemp crop using knowledge and infrastructure currently used in the tobacco industry. Further, it is believed that South Africa could undertake secondary value-added production of primary and intermediate industrial hemp exports from Malawi. This division of value chain activities appears rational as industrial hemp cultivation, harvesting, and primary processing is labour-intensive, and Malawi has an agricultural wage rate advantage over South Africa. Similarly, South Africa's capital base, spare capacity in several value-adding opportunities from industrial hemp feedstock, higher labour productivity and skills profile, stronger domestic markets, and a more health- and environment-conscious consumer base, all back the idea of exploiting downstream industrial hemp production opportunities in South Africa.

This joint potential opportunity is somewhat supported by current legislative agendas and existing laws. The commercial-scale cultivation of industrial hemp as an agricultural commodity in South Africa remains prohibited, whereas in Malawi a Bill to study the potential of industrial hemp as an alternative cash crop was drafted and passed in 2015. As a result, two licences were issued to undertake further studies. These studies were completed in 2018 and a summary of the findings submitted to the Cabinet. According to the Principal Secretary of the Ministry of Agriculture, Irrigation and Water Development, 'the Ministry is ready with the results but they cannot be shared with the public yet' (Nyale 2018). Insiders suggest that the results will be positive. While South Africa is unable to cultivate industrial hemp, there are no restrictions on importing industrial hemp fibres or seeds (as long as they are sterilized). Stalks and leaves can be imported as long as they are partially processed. Therefore, while creating a Malawian–South African industrial hemp value chain is not yet a reality, it appears likely that the opportunity will—at least in principle—be realized sometime soon.

This study considers the potential of the industry for both countries and the conditions and arrangements that need to be put in place to leverage the potential of industrial hemp into tangible commercial opportunities in Malawi and South Africa. It will be shown that such an endeavour would be considerably more complicated than initially envisaged and that substantial additional research (especially market research) would be required. The present research does, however, support a finding that industrial hemp offers strong opportunities as a niche market even if mainstream demand is slow to materialize or does not materialize at all. Given the current tobacco industry structure and market operations in Malawi, and given the processing capacity in South

Africa, there are no serious constraining factors to developing this potential value chain (assuming of course that Malawi does legalize the cultivation of industrial hemp as expected).

Sections 2 and 3 consider demand-side issues. Section 2 starts with an introduction to the industrial hemp plant and its physiology, both in its uses and in its differentiation from its narcotic cousin marijuana. Section 3 focuses on the demand drivers of the current increased interest in the crop. It identifies three key drivers: faith in industrial hemp as 'the farmer's best friend' in that the crop is relatively low-input and low-management with multiple soil-enhancing capabilities; belief in industrial hemp as 'the environmentalist's best friend', both as a crop per se and for its use as a feedstock for the production of green alternatives to traditional products; and finally, demand for industrial hemp as a 'super food', as a source of therapeutic compounds that can be used as health supplements and inputs to cosmetics and personal care products, and CBD[1] oil.

Sections 4 and 5 shift attention to the supply side. Section 4 focuses on global legislation pertaining to industrial hemp cultivation and processing, with an overview of global production volumes and the main cultivating countries. Section 5 looks more closely at the actual cultivation of industrial hemp as a crop and considers seed-breeding options for different end uses; planting and growing agronomic and management practices, with an emphasis on inputs; harvesting practices and the dependence on labour-intensive rather than capital-intensive processes.

Sections 6 and 7 consider market dynamics and the issues around establishing and ultimately developing a novel crop into a mainstream agricultural crop. The findings of Section 6 are crucial for any future policy thinking related to an industrial hemp value chain, as it focuses on understanding different end uses of hemp and the costs and selling prices of—and hence the margins attributable to—competing end uses of the crop. The analysis also introduces the complicating factor of growing a crop for a dual purpose if a mono crop is commercially unviable. Section 7 looks at the steps, opportunities, and potential pitfalls relating to the introduction of a novel crop into the commercial market.

Sections 8 and 9 look at the opportunities and potential of industrial hemp as a viable value chain for development between Malawi and South Africa. Currently, the Malawian government is debating the legalization of industrial hemp cultivation, and it is this process that triggered this research. The findings of Section 8 are crucial for any potential future policy evaluation, as it looks at tobacco farming in Malawi and the contract-buying, tied-producer value chain structure that operates and defines agricultural activity in the country. This analysis suggests that industrial hemp could be a viable alternative rotation cash crop for Malawi's tobacco farmers but that such diversification would need to duplicate the input subsidization and contract-buying aspects of the current tobacco system. These requirements raise numerous challenges, although they are not viewed as binding constraints. Section 9 considers the potential of upstream cultivation in Malawi and downstream processing in South Africa. The research suggests that there are no binding constraints to South Africa's processing firms being able to import industrial hemp feedstock from Malawi (although there are areas of uncertainty with regard to processing for human usage). It also shows that South Africa has commercial-scale processing capabilities for cold pressed oil extraction, essential oil extraction, and the production of cosmetics and personal care products. The country also has Good Manufacturing Practice (GMP) capacity for producing foodstuffs for

[1] Cannabidiol, commonly known as CBD oil, is a compound found in cannabis.

human consumption and solvent-based extraction capabilities for producing therapeutic-standard (but not medical-standard) CBD oil.

Section 10 concludes and finds that, although there is uncertainty as to the potential of the industrial hemp market, there is sufficient existing niche market demand to support the further investigation of industrial hemp as a regional value chain between Malawi and South Africa.

2 The industrial hemp plant and its uses

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 and was seen as crucial in supporting the global expansion of shipping, trade, colonization, and military activity during the period (Young 2005). By the 20th century, the development of steam-powered and petroleum-fuelled engines eroded the largest source of 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 essentially disappeared globally as an agricultural crop in the second half of the 20th century. This disappearance has implications for the current commercial opportunities for the plant and its downstream products, as no research and development or technology development related to the crop or its processing has taken place in seven decades.

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 greatest density in the female flowers of the plants, followed by the leaves, stalks, and roots.

There are two kinds of cannabinoids found uniquely in the Cannabis sativa plant. Tetrahydrocannabinol (THC) is a psychoactive chemical and responsible for the narcotic 'high' experienced when consuming marijuana. CBD is a non-psychoactive cannabinoid, has no narcotic properties, and cannot produce any form of 'drug high'. The key differentiator between industrial hemp and marijuana (legally and chemically) is that industrial hemp has very low levels of THC. In countries that allow hemp cultivation, it is generally accepted that plants with less than 0.3 per cent THC do not have narcotic properties and can therefore be grown commercially. More specifically, in terms of legislation, Canada, the United States of America, South Africa, and most non-European Union (EU) countries in Europe define industrial hemp as any cultivar of Cannabis Sativa with a THC level below 0.3 per cent. In the EU, industrial hemp must have a THC level no higher than 0.2 per cent.

The industrial hemp plant is a fast-growing, annual herbaceous plant with a deep tap root. It can grow up to 5 m high, depending on the cultivar and growing conditions. 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. 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, which contain seeds, seed oils, and the 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 1). Importantly, these different plant and cultivation traits suggest that differentiating between industrial hemp and marijuana is not as challenging as critics suggest and the crops would not look similar when cultivated for their specific end uses.

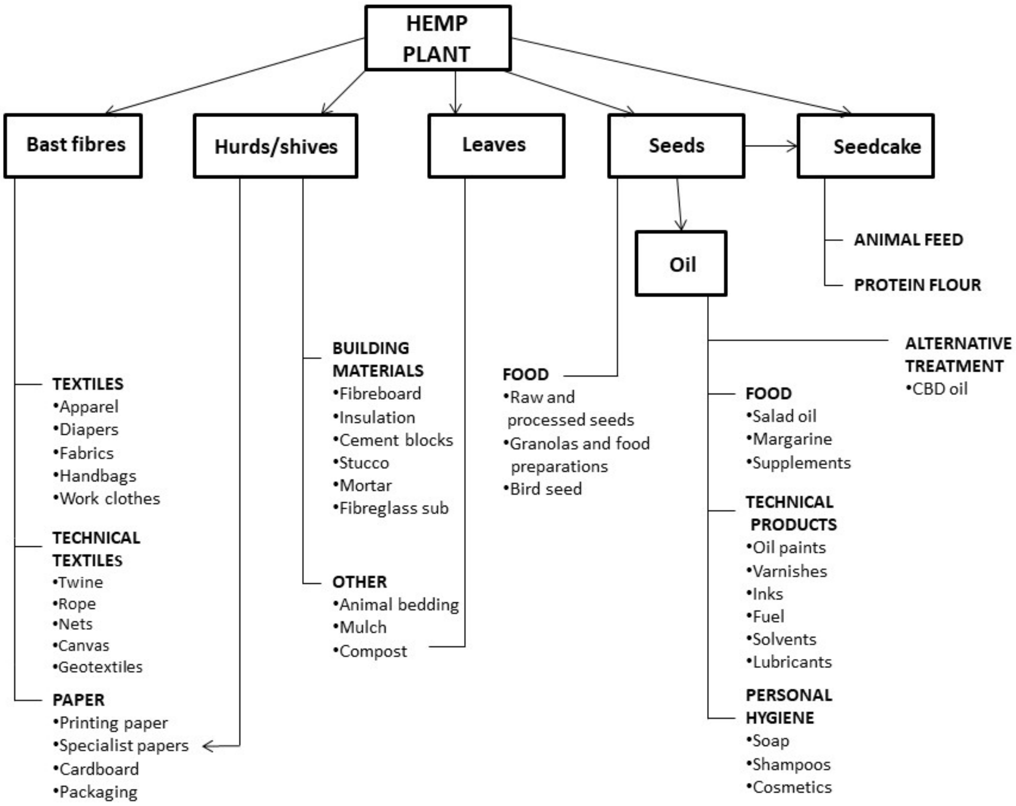
Table 1: Comparative characteristics of marijuana versus industrial hemp

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

Source: author’s compilation based on Coogan (2016); Lowitt (2018).

Figure 1 provides an overview of the uses of different parts of the industrial hemp plant.

Figure 1: Industrial hemp plant uses



Source: author's illustration based on figure retrieved from a CRS report.[2]

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

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, and carpets and geotextiles. For centuries, hemp fibres have also been used in the production of paper. In the modern era, bast-fibre paper is used for the manufacture of bank notes because of its tear resistance and tensile strength and durability. Bast fibres are also used in the production of ultra-thin paper such as that used in cigarettes and bibles. Recent technological innovation has enabled a third use of hemp fibre, namely the production of bio-composites.

Bio-composites are materials formed by a matrix (resin), which is then reinforced with natural fibres. The addition of fibres allows a composite to be strong and shatter-resistant, yet light and flexible. These characteristics (as well as the green credentials of bio-composites) are highly sought-after in the building and construction, and plastics and materials manufacturing industries. In building and construction, hemp fibre is used as a substitute for fibreglass and woodchips in the production of lightweight, strong, flexible, and highly insulating fibreboards, insulation materials,

---

[2] Source of figure retrieved shows: Industrial Hemp Association of Tasmania, www.ihat.org.au (not found). CRS report: author [name redacted] (2018). *Hemp as an Agricultural Commodity*. Washington, D.C.: Congressional Research Services. Available at: https://www.everycrsreport.com/files/20180622_RL32725_c276fc644a1629238199b60e4c744d9f06260a33.pdf (accessed February 2020).

concrete blocks, stucco, and mortar. These uses increase both the functional and environmental characteristics of the building materials.

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 for the production of injection-moulded parcel shelves, door panels, instrument panels, arm rests, head rests, and seat shells. This switch has been driven by performance requirements (especially weight) but also by EU legislation, which requires increased recyclability for the end-of-life automotive parts. Audi, BMW, Ford, Honda, Mercedes, and Volkswagen all use bio-composites, the choice of fibre between hemp, flax, and kenaf being based on cost and availability.

In the modern era, when green and renewable energy sources are increasingly being sought, industrial hemp is also being considered as a source of both biomass and biodiesel. It is argued that the whole industrial hemp plant can be used as biomass for energy applications, although currently the only commercial application is the niche market of pellets for residential wood-burning stoves. Ethanol can in principle be produced from the cellulose in hemp fibre. The green credentials of industrial hemp as a renewable energy source are, however, strongly contested and analysis is severely hampered by the lack of research. At present, the only fair conclusion to draw is that it is ‘unclear whether hemp is any better than its competitors’ (Fortenbery 2014: 11). These issues are dealt with in more detail below.

Turning to the plant’s seeds, industrial hemp offers the second-highest source of protein in the plant kingdom, soybeans being 7 per cent richer. 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 seeds can also produce hemp seed oil.[3] This can be used in food, in body care and cosmetic preparations, and in therapeutic as well as industrial applications, e.g. in paint, ink, varnish, sealants, cleaners, and lubricants, where it is seen as a greener alternative to synthetic and fossil fuel-derived inputs. 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, both of 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.

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. Research into CBD oil has been hampered by the illegality of growing Cannabis sativa but as legislation is relaxing so increased research and evidence is accumulating. CBD oil is claimed to be 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

[3] Hemp seed oil is the oil obtained by cold expression from the ripened fruits (seeds) of Cannabis sativa.

detail below, as it is seen as the best income-generating downstream product of the hemp plant in the current market.

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, and existing research shows that cows, sheep, fish, and egg-laying hens all thrive on the product.

Finally, 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.

3 Demand drivers

Understanding the drivers of demand for industrial hemp is crucial for any consideration of the potential development of an industrial hemp value chain and increased regional trade. At present the crop and its products are characterized as 'novel' and 'niche'. Current production is limited, demand is thin, and trade volumes are low. Consequently, decisions as to its commercial viability and investment in the sector must be based on projections and perceptions of likely market development rather than on existing market opportunities.

Scanning the literature, three recurring arguments are put forward by proponents of industrial hemp, who predict substantial and important growth opportunities and are seeking to lift the prohibitions on the crop's cultivation and processing.

The first argument is 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 hybridized, and cultivars and varieties can be bred to support specific plant characteristics within just seven generations. The plant is a fast grower, meaning that 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 in excess of current agricultural crops in general, and tobacco in particular. This argument is dealt with below when market prices and commercial viability are considered.

The second, and loudest, argument made in favour of lifting the ban on industrial hemp and supporting the growth and development of the agricultural crop at scale is based on its green credentials. First, industrial hemp is argued to be less environmentally degrading than other agricultural crops. This is largely related to the argument that industrial hemp is typically a low-input, low-management, low-technology crop. Hemp proponents argue that the crop is highly pest-resilient and disease-free, resulting in the need for fewer pesticides. As mentioned above, the plant's fast growth pattern makes it a natural weed suppressant, meaning that no herbicides are required. It is also argued that the crop has less need of fertilizer 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). The low-input usage of industrial hemp is, however, contested, the general counter-argument being that 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. If it is grown for seed, on the other hand, the inputs and management required 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. undertook to compare 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 unit of textile (Cherrett et al. 2005). Table 2 shows the findings for both crop cultivation and fibre production of the three alternative products.

Table 2: 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).

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 that of cotton, but analysts seem to agree that this is largely because no commercial research and development (R&D) has been done on natural fibre production, in contrast to the 50-year legacy of production and processing improvements in the cotton industry.

Industrial hemp as a feedstock substitute for wood in the production of paper 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 the production of paper. In addition, hemp paper resists discolouration and 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 pulp. Therefore, there tends to be a current 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 instrument 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. 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. 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.

The third main argument in favour of industrial hemp relates to its food, personal care, and therapeutic uses. These three uses collectively account for 64 per cent 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, predominance of 'good', polyunsaturated fats, and high levels of 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 having been consumed in China and other developing nations and being 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 are 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 will be shown below, trade volumes in industrial hemp seeds for human consumption have been increasing consistently over the past 10 years, with prices also rising substantially as demand outstrips supply (Johnson 2018).

Just as there is no dissenting view on the health benefits of industrial hemp seeds, hemp oil, and hemp-seed flour, so there is no disagreement 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, and the shift towards sustainable, natural, and environmentally friendly personal care products is well established and growing strongly in developed countries. Currently, for example, industrial hemp personal care products account for 24 per cent of total industrial hemp retail product sales in the US (Johnson 2018).

By far the most talked about, controversial, and often misunderstood argument for the lifting of restrictions on industrial hemp relates to the merits of CBD oil and its medicinal and therapeutic uses. CBD oil is claimed to relieve inflammation and pain, lower cholesterol and blood pressure, reduce seizures, and aid sleep. To date, all rigorous testing of CBD oil as a medicine or therapy, or even as a health supplement, has been based on medically grown narcotic cannabis and not commercially cultivated industrial hemp. Although in theory a CBD molecule is a CBD molecule, whether it is derived from industrial hemp or its narcotic cousin marijuana, in reality there are important differences that need to be considered before taking a view on the commercial viability of industrial hemp based on cultivation for CBD oil uses.

Over the past 10 years, increasing amounts of research have demonstrated the medicinal benefits of cannabis. 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 US$190 million out of a legal cannabis market (CBD plus THC) of US$2.5 billion (Lowitt 2018).

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 the 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 that 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.

From a commercial perspective perhaps the most important difference between CBD oil derived from industrial hemp and that derived from medical marijuana lies in the CBD content of the two plant cousins. Industrial hemp plants contain only 3–5 per cent CBD, whereas the marijuana plant contains 18–20 per cent CBD. 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 only limited medical and therapeutic characteristics compared with those of 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.

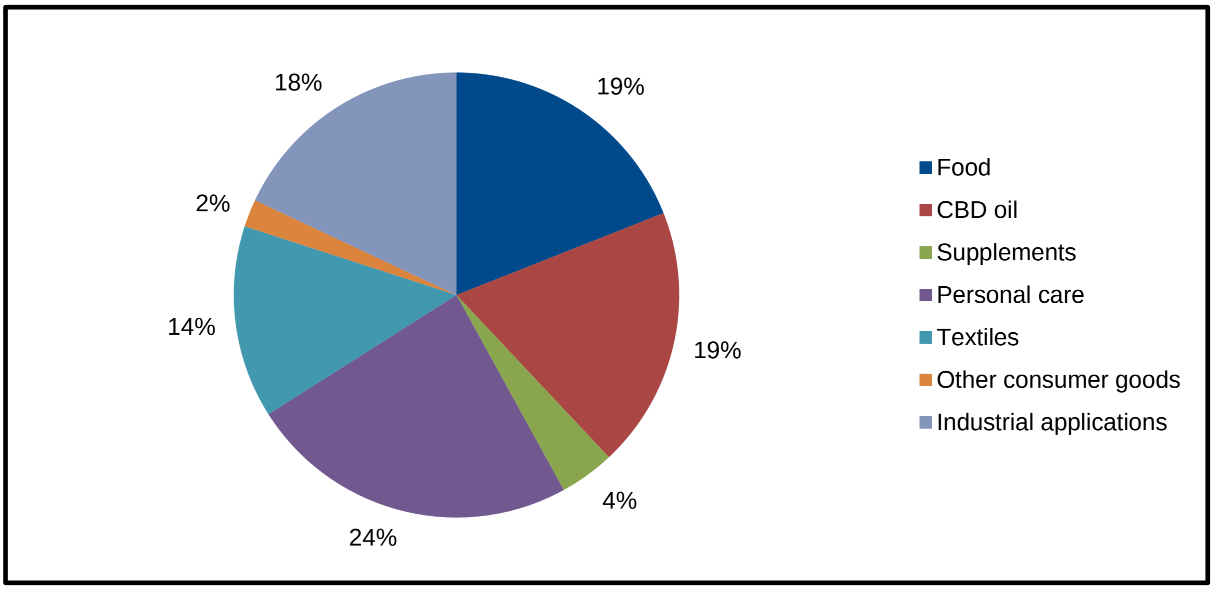
In addition, industrial hemp CBD oil is derived from the cold press extraction of hemp oil from the seeds, whereas medical grade cannabis and CBD oil uses solvent extraction or super critical carbon dioxide fluid extraction. These different extraction processes also mean that CBD oil derived from industrial hemp is of poorer quality and less pure than that extracted from medical marijuana.

Despite these three 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. These three aspects are dealt with below in greater detail when commercial viability is considered.

It is impossible to make an accurate assessment of 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 both describe a general trend towards increased trade and increased retail sales over time. Unsurprisingly, total values remain low in absolute terms. For example, the biggest 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 industrial hemp trade, they do provide substantial 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 2 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 and has a more even distribution of uses as well as a profile of higher-value-added uses. The personal care market is particularly strong in the US 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 strong. Industrial application demand lags behind consumer consumption uses at present, but with R&D on the crop increasing, industrial applications are expected to increase.

Figure 2: Breakdown of industrial hemp retail sales in the US, 2016



Source: author's construction based on Hemp Industries Association (n.d.).

The largest retail market in the world, the US also accounts for 60 per cent of global trade in industrial hemp products. Table 3 indicates the value and trend of imports to the US over the past five years.

Table 3: US imports of industrial hemp (US$'000)

	2013	2014	2015	2016	2017
Seeds	26,942	29,326	54,191	51,018	42,897
Oils	2,264	3,446	4,836	6,142	7,603
Seedcake	6,279	8,159	16,281	8,620	11,494
Fibres	78	114	292	690	780
Yarn	482	909	1,497	1,867	2,739
Woven fabrics	1,057	900	1,020	744	1,819
Total	37,102	42,854	78,117	69,081	67,322

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

It is obvious that 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 decreases 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 not available, but data are available on cultivation and downstream uses. 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 tonnage, 63 per cent was used in the production of animal bedding, 16 per cent in construction, and 19 per cent 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 per cent were used in animal feed, 43 per cent for human consumption in various foods, 13 per cent to extract oil for human consumption (food application, not CBD), and only 0.3 per cent to extract oils for cosmetic and personal care 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 per cent of usage, compared with 23 per cent 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 summary, the three demand drivers of 'farmer's best friend', 'environmentalist's best friend', and benefits as a 'super food' and therapeutic and personal care product collectively suggest that a future industrial hemp market does indeed hold great potential and possible 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 potential of the crop in a wide variety of 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 a valuable input for developed countries' value chains, where higher-value-added products are produced and sold.

Despite this potential, two cross-cutting themes or cautions appear in most of the demand-side literature. The first is that there is a lot of hype around industrial hemp as a 'saviour' crop: the green solution to industrial-age manufacturing, the renewable energy alterative, or the marvel therapeutic and medicinal plant. Whether this hype will translate into commercially viable economic opportunities and dynamic markets is obviously unknown and untested in the main, given existing legislation. At this point, market realities remain sufficiently constrained that future investment and commercial behavioural 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.

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 the cultivation, harvesting, production, or final good development of industrial hemp. As will be shown in the next section, this lack of technological development has a substantial impact on the commercial viability of all stages of the value chain—from the harvesting stage, where existing combine harvesting technology is inappropriate for cutting hemp plants, to the processing stage, where the costs of processing hemp fibres are so much higher than for cotton fibres because of the antiquated spinning technology available in hemp production facilities. These constraints and limitations will be eased if more industrial hemp is made available for scientific study and experimentation, which will naturally occur as market demand for green substitute 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 likelihood expand when and if research efforts increase.

4 Legislation and production

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. At present, 30 countries (including Australia, Austria, Canada, Chile, China, Denmark, Egypt, Finland, Germany, Greece, Hungary, India, Italy, Japan, Netherlands, New Zealand, Poland, Portugal, Romania, Slovenia, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, the UK, and Ukraine) and 34 US states permit some production of industrial hemp. In all these countries and states, 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 none of these countries is industrial hemp not regulated, even if it is legal.

The key players in the industrial hemp market are the US, Canada, China, and the EU. A brief overview of their legislation and regulation will provide some sense of the variation in approach to legalization, regulation, and ultimately use of industrial hemp and its downstream products.

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 with an eye to supplying 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 per cent to 9–10 per cent. On this basis, the pilot projects were considered an agricultural and commercial success. With the 2018 Farm Bill, President Donald Trump paved the way for the legalization of industrial hemp at federal level. Under the 2018 Farm Bill, industrial hemp is no longer considered a controlled substance as long as it has a THC level below 0.3 per cent. It is now considered an agricultural product and falls under the control and supervision of the US Department of Agriculture and not the Drug Enforcement Agency (DEA). Cultivars with higher CBD content but THC levels below 0.3 per cent have been cleared by both 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 regulation of CBD oil are expected soon. 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 state level, and in all states where industrial hemp cultivation takes place licences 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.

In Canada, industrial hemp cultivation was officially legalized in 1998. As in the US, industrial hemp is legal as long as its THC content is below 0.3 per cent. Although the crop is legal, it is strictly monitored and regulated, with licences 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 because, 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 grows industrial hemp for seed and seed only, with no production for fibre or CBD oil. Therefore, most controls and regulation related to the crop have to do with maintaining seed quality and the cultivation and harvesting of seeds with the best protein, polyunsaturates, and omega oil profiles. Most of these regulations are determined by the Canadian Food Safety Authority rather than the Canadian Agency for Drugs and Technologies in Health.

China is currently the world's largest producer of industrial hemp 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. This will be explored below in greater detail.

Industrial hemp cultivation and supply are also legal under EU regulation 1308 of 2013, as long as the plant has THC levels below 0.2 per cent. Not only is industrial hemp legal in terms of EU regulations, but the crop qualifies for subsidies under the Common Agricultural Policy. Subsidies and research support programmes are available as long as specified varieties are used, seeds are certified, and testing and verification measures are adhered to. Despite this general EU legalization, individual member states regulate hemp production and cultivation licensing as they see fit, and regulations controlling the use of industrial hemp-derived products differ substantially and are in a state of flux at present. For example, up until 2016, the UK had no regulations controlling CBD oil. In May 2016 it was designated a medicine for the first time and suppliers were suddenly required to obtain 'marketing authorisation' or a 'traditional herbal registration' through the Medicines and Healthcare Products Regulatory Agency. CBD regulations are becoming more common across all countries as general demand for the product increases and authorities seek to protect consumers from unregulated and unsafe supplies.

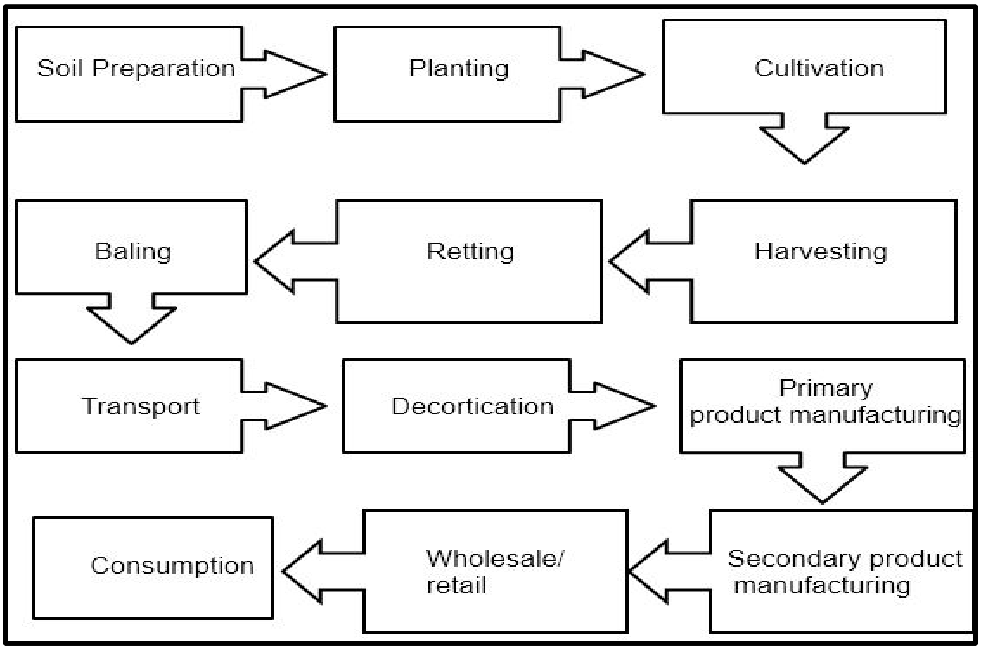
Despite industrial hemp cultivation being legal in 30 countries, there are presently fewer than half a dozen dominant producers. No official data exist on current production volumes, crop differentiation (fibre or seed), or trade in differentiated industrial hemp products, but most sources agree that China is the dominant global supplier of industrial hemp, producing roughly 70 per cent of global output, though, as has been said, its production is currently focused exclusively on fibre production. Canada is said to be the second-largest producer at roughly 15 per cent of the global market; however, it produces only seed 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 per cent of global production. France produces industrial hemp almost exclusively for the paper industry and more specifically paper used in cigarette production.

An important point to note is that industrial hemp cultivation remains a minor and insignificant crop both 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 even constitute 1 per cent 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.

5 Cultivation and harvesting

Figure 3 suggests that the cultivation of industrial hemp and its initial harvesting and preparation for manufactured applications is relatively straightforward. This could not be further from the truth. Hemp is a multi-use, multi-functional crop that provides raw materials to a large number of 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. As will be shown in the commercial viability section, the fact that there is strong disagreement over whether industrial hemp is more commercially viable as a dual-purpose crop than a single-end-use crop merely adds to an already complex cultivation and usage decision.

Figure 3: Industrial hemp activity flow



Source: author's construction based on information from South African Department of Agriculture, Forestry and Fisheries (DAFF) website.[4]

Industrial hemp is grown by seed, with virtually every regulatory body responsible for licensing insisting on the use of certified seeds bought annually. This is to ensure 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. Seeds are usually planted between September and November in the Southern hemisphere on beds that have been prepared in a manner similar to other row crops. 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. If the crop is to be grown for commercial purposes, it is suggested that

[4] See https://www.daff.gov.za/daffweb3/Portals/0/Agricultural%20Marketing%20Commodity%20Profiles/HEMP%20MARKET%20VALUE%20CHAIN%20PROFILE%202012.pdf

potassium, nitrogen, and phosphorus be added to the soil before the seeds are planted, although this is contested by some agronomists, who argue that additional nutrients are not required. Germination occurs within three to five days of planting, and it is recommended that at this stage, if there is no rainfall, the crop be watered at a rate of 3ML to 6ML per hectare. 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.

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 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/m^2, for paper and pulp 90/m^2, for essential oil 15/m^2, and for CBD oil 10/m^2. These greatly different densities suggest that scales of farming, yields, and commercial feasibility will differ according to the end use of the crop.

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.

End use is also a crucial variable 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 the yield of biomass and stem production, 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—largely 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 combine harvester designed for wheat or corn, but the cutting and mowing mechanisms will regularly get stuck and clogged up, and machinery parts will wear out rapidly, negatively impacting the efficacy of using the equipment. Because there has been no commercial-scale cultivation of industrial hemp for over five decades, purpose-built industrial hemp machinery has not been developed, although German and Canadian companies are looking at customizing existing combine harvesting equipment for the industry. Therefore, there is currently an advantage in manual harvesting.

Once the stalks have been cut, a process called retting is required when harvesting for fibre. This is a process of decomposition designed to separate the usable bast fibres from the woody hurds. Retting can be done in three ways. 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, water retting can be carried out instead. In this process decomposition and the separation of fibres occurs while the stalks are under water. Water retting takes less time than paddock retting but is more labour intensive. The third option is enzyme retting. For this, suitably sized tanks are built and filled with water and an enzyme added that degrades the cell walls of the plant. This is the fastest method of retting but also the method that requires the most expensive inputs (enzymes) and the largest investment of infrastructure (water tanks).

Once retting is complete, the stalks are dried until they have only 10–15 per cent moisture content, at which point they are baled and transported for processing. The next step is the actual separation of 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 related to this process except in China.

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 seed. The optimal window for seed harvest is when 70 per cent of the seed is ripe and seed moisture is at 20–30 per cent. Delaying harvesting may increase yield but quality will decrease as the seeds dry out further. Harvesting for seed and oil requires the harvesting only of the flowers, not of the whole plant. Hand-picking is the best option to ensure quality and reduce seed damage but is obviously labour-intensive. Alternatively, harvesting can be done using combine harvesters set to cut off only the top of the plant. Because there is less volume of fibre, a lower stalk diameter, and less 'stickiness', traditional combine harvesters do not break down as often as when being used for whole-plant harvesting.

When hemp is grown for CBD oil, only hand-harvesting works, as 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 as well. When harvested for CBD oil, the flower heads (or larger 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 completely dry (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 need to 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.

6 Market dynamics

Commercial viability calculations are crucial when considering reallocating resources to the cultivation of 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 six feasibility studies: four from the US (Fortenbery 2014; Heister 2008; Johnson 2018;

Robbins et al. 2013), one from Australia (Crawford et al. 2012), and one from South Africa (Budden, cited in Coogan 2016).

Key to any view on commercial viability is the selling price of upstream and downstream products. 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) sell for as little as US$50 per tonne (Crawford et al. 2012) or R3.50 per kilogram (Coogan 2016). Values start increasing as soon as the plant is processed. Tables 4, 5, and 6 show market prices for different levels of processing and different downstream products.

Table 4: Relative prices for downstream hemp products in South Africa, Rand/kg (2015)

Product	**Price**
Stalk fibre	9
Stalk hurd	6
Oil	100
Seedcake	50
Dehulled seeds	115
CBD oil extract	10,000

Source: author's compilation based on Coogan (2016).

Table 5: Relative prices for downstream hemp products in the US, US$/kg (2003–2013)

Product	**2003**	**2009**	**2013**
Hemp seeds	-	5.47	9.08
Hemp oil	6.36	8.14	5.03
Seedcake	-	9.01	10.45
Fibres and waste	0.87	1.36	1.08
Yarns	7.02	7.47	6.89
Woven fabric	1.65	3.40	4.72

Source: author's compilation based on Fortenbery (2014).

Table 6: Relative prices for upstream and downstream hemp products in Australia, US$/ton (1995)

Product	**Price**
Raw stalks	55
Dry stems	125
Raw fibres	647
Dry fibres	800
Bast fibres	630
Hurds	55
Dry hurds	40
Seeds	1,200
Organic seeds	1,680

Source: author's compilation based on Crawford et al. (2012).

The tables show a high level of variation in absolute values for different products but are consistent in relative values for different downstream uses. In primary processing, hurd (the woody core of the plant, used predominantly for animal bedding) is the least valuable processed output. This is followed by fibres, oil, and seeds. With secondary processing and increased value addition, price differences are less consistent across the studies, reflecting the different uses and demand in the three countries.

In South Africa, little 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 that there is market knowledge and interest in the health and wellness aspects attributed to industrial hemp. Finally, the extraction of CBD oil from the plant returns the highest market price by a massive margin. Looking at Table 4, the only logical conclusion is that any cultivation of industrial hemp in South Africa should be for the end use of CBD oil extraction. As will be discussed, this is problematic from a sustainability perspective, and the differential should be seen as a short-term boom, which will disappear as marijuana legislation changes, as synthetic substitutes are developed, and as the input product becomes commoditized as supply increases.

In Australia, the key market opportunity identified by the price differentials is the use of industrial hemp as a 'super food', the strongest prices being identified for seeds—and 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, a 40 per cent premium being attached (Crawford et al. 2012). Unlike South Africa, Canada and Australia have medical marijuana programmes and thus there is little to no market for industrial hemp-derived CBD oil, 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 are the next big driver of value in the US market, with seed becoming more valuable over time according to time series data. 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 the production of industrial hemp, all the interviewed farmers related that they were cultivating industrial hemp solely for the purpose of producing CBD oil. They claimed that they were achieving US$30,000 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, it is fair to assume that, as in the other case studies, processing industrial hemp into CBD oil achieves the highest price of all alternative uses in the US as well.

From the above, it can be argued that at present the two largest drivers of demand for industrial hemp end products outside China are: industrial hemp seed as a health food input and industrial hemp as a source of CBD oil. Prices for fibres may improve in the future as more industrial substitute products such as bio-composites and tree-free paper are demanded, but at present price signals indicate that focus and demand are driven by the health food and CBD markets, followed by the oil market as an input for personal care and cosmetic products. Market prices for industrial hemp fibre for the production of fabric and/or apparel remain relatively low.

In terms of achievable margins, all these studies look at non-CBD uses only. The Australian study makes assumptions about input costs (which are higher when the crop is produced for seed) and yield, and then computes the margin per hectare in Australian dollars based on a high-, medium-, and low-price scenario. We compare these margins with the gross margins of other agricultural crops; the findings are shown in Table 7.

Table 7: Comparative gross margins per hectare of crops in Australia, A$ per hectare (2012)

Crop	Gross margin per hectare
Canola high price	1,199
Canola low price	1,085
Lentils medium price	834
Barley low price	559
Wheat low price	425
Chickpeas low price	386
Industrial hemp seed low price	-100 (selling price 1,600)
Industrial hemp seed medium price	800 (selling price 2,500)
Industrial hemp seed high price	1,800 (selling price 3,500)

Source: author's compilation based on Crawford et al. (2012).

The Australian data show that cultivating industrial hemp for the end use of seed is competitive in comparison with other agricultural crops only at a high global price. At a medium price, farmers would be better off cultivating canola, 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 key problems with the industrial hemp market at present. Currently, traded volumes are small and markets are thin. In addition, global production is shared across only a handful of countries, China dominating global supply with a 70 per cent share of world exports. Therefore, China's production decisions disproportionately impact the global price, as seed producers discovered at the end of the 1980s.

Historically, China has always grown industrial hemp for fibre and supplied this to the domestic market, only a small percentage of output being exported. Prior to 1986, China had never produced industrial hemp seed. Between 1986 and 1988, China shifted its cultivation priorities away from fibre into seed. Between 1986 and 1991, China's global share of the seed market increased from 0 per cent to 76 per cent (Crawford et al. 2012). 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 per cent from 26 cents per pound to 15 cents per pound. In 1992, China abruptly decreased its production of seed, global traded volumes fell to 7,000 tons, and prices recovered to 23 cents per pound (Crawford et al. 2012). High price volatility and its impact on farmer margins is a threat in any market with low traded volumes. This is one of the difficulties in establishing novel crops as mainstream crops.

By far 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 undertaken specifically to consider the crop as an alternative to tobacco in Kentucky. The study excludes the end use of CBD oil. Interestingly, as a response to thin markets, price volatility, and uncertain future demand, the Robbins work considers an idea touched on by many scholars in the field—namely, the idea of cultivating industrial hemp for more than one end product use (Coogan 2016; Dietz 2013; Fortenbery 2014; Heister 2008).

The Robbins research looks at the potential of growing industrial hemp for fibre and for seed. It looks at a low-price scenario—fibre selling at US$50/ton and seed selling at 50 cents/pound—

and a high-price scenario—fibre selling at US$100/ton and seed selling at 90 cents/pound. Robbins also looks at the quality of the land on which the crop will be grown and distinguishes between medium-productivity land and high-productivity land (Tables 8 and 9).

The findings of the 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. As expected, 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).

Table 8: Low price net return scenario per acre, US$

	Medium-productivity land	High-productivity land
Fibre only	-292	-314
Seed only	67	202
Dual production	-74	12

Source: author’s compilation based on Robbins et al. (2013).

Table 9: High price net return scenario per acre, US$

	Medium-productivity land	High-productivity land
Fibre only	-5	89
Seed only	367	622
Dual production	323	569

Source: author’s compilation based on Robbins et al. (2013).

In summary, it appears that with current market dynamics and prices the best possible end use (excluding CBD oil) for industrial hemp grown as an agricultural crop would be to cultivate for seed to meet the demand for health 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 at present and would be in direct competition to the current world leader in hemp production—China. However, the EIHA (2018), Fortenbery (2014), and Robbins et al. (2013) all concur 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. This not only increases production costs but also decreases the environmental benefits of the crop. Growing for seed requires gentle handling of the flower to minimize shattering. Labour-intensive methods of harvesting can be considered as potentially competitive with mechanical harvesting, as would be done in developed countries. Nevertheless, the seed market is currently the most robust end-use market and, with Australia and the EU reconsidering regulations to make seed legal for human consumption, future demand trends look positive.

Fortenbery (2014) and Johnson (2018) both conclude that industrial hemp (excluding production for CBD) is slightly more profitable than other row crops but less profitable than speciality crops. Further, all the authors of all the viability studies stress the point that current markets are thin and prices highly volatile. Decisions to shift to the production of industrial hemp would thus be based more on a view of future market potential than existing market opportunity.

Including 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. Given the price differentials shown above, in the short to medium term industrial hemp will be cultivated for CBD oil as an end use except in countries where medical cannabis cultivation is legalized (Australia, Canada, and some US states). As explained in Section 2, 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 legalized, CBD oil will be produced from marijuana crops, not industrial hemp crops. But in countries (and US states) where industrial hemp cultivation is legalized but marijuana cultivation is not, a gap in the market exists for CBD oil from industrial hemp to meet market demand.

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 hence driving down its price. This commoditization of CBD oil would mirror the trend already established in the medical marijuana market, where in a period of three years prices for medical marijuana in Colorado, for example, decreased from US$5,000 per pound to US$800 per pound.

7 Establishing a future industry

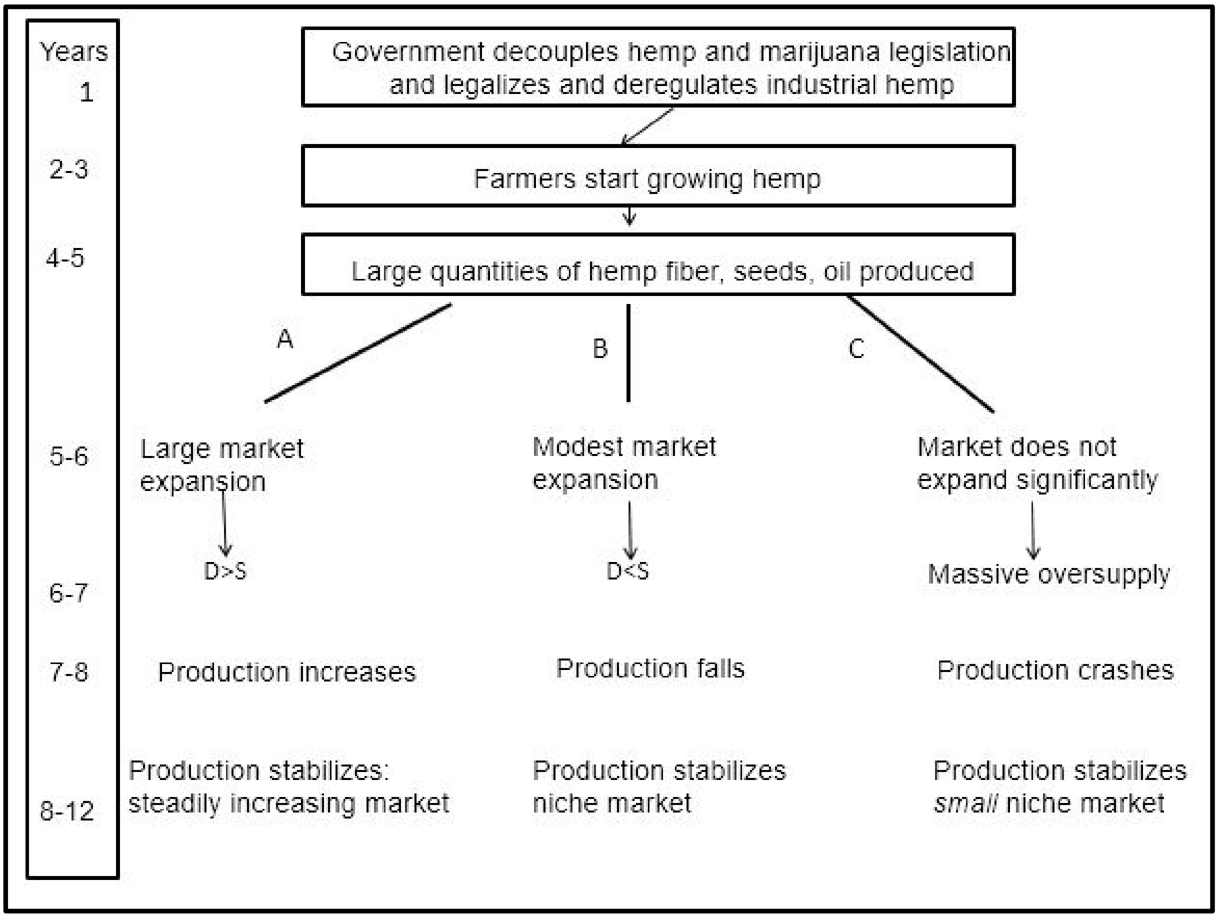
Cherney and Small (2016), in their work considering the potential of industrial hemp as an agricultural crop in the US, add to the above body of knowledge by including in the debate not just the issue of future demand for industrial hemp and its downstream products but also the issues of what is actually necessary to transition a novel crop into a mainstream crop. Their views are shared by other researchers. Cherney and Small suggest that there are always new 'miracle' crops on the market. They cite kernaf, meadow foam, teff, spelt, switch grass, and comfrey as examples of novel crops that have captured popular and agricultural circles' imaginations in the past 20 years. They go on to argue that novel crops typically come with agronomic, processing, conversion, economic, or social issues that prevent them from achieving their potential. They believe strongly that the same applies to industrial hemp and that much of the interest in industrial hemp is based on hype rather than reality.

Of all these possible constraints, the most significant for industrial hemp are processing capacity and technology. As argued earlier, because there has been no commercial-scale cultivation of industrial hemp (anywhere but in China) over the past 50 years, investment in or R&D into processing industrial hemp or developing technology related to downstream hemp product manufacturing has not happened. Without processing capacity, market demand will fail to flourish, and industrial hemp will remain a novel, niche-market crop. Crawford et al. (2012) back up Cherney and Small's negative outlook and suggest that, even if hemp cultivation volumes increased substantially so as to decrease its price as an input feedstock, the current state of hemp processing technology would render any hemp-based products uncompetitive with existing alternatives. Crawford et al. also highlight that, even during the last 10 years of hype about industrial hemp, no multinational companies have become active in the market, suggesting that they cannot make it work in the marketplace. This leads the authors to conclude that industrial hemp may not in fact be such a good idea after all.

Cherney and Small, and Crawford et al. also raise the issue that industrial hemp plants are enormously bulky and that transport costs could undermine margins down the value chain. This problem would only be mitigated if production facilities were located close to land under cultivation, but such a scenario seems unlikely given existing economies' tendency towards agglomeration and manufacturing clusters. Other constraining factors include the agronomic risk that, as industrial hemp becomes more widely cultivated, so its rate of pest and disease incidence will increase, resulting in increased application of pesticides, which will drive up input costs and nullify some of the crop's green credentials.

The above information, data, and opinions speak to the reality that the future of the industrial hemp market and its potential for growth and development are neither straightforward nor obvious. Almost all researchers suggest that uncertainty and risk characterize the (potential) sector and that substantially more research and data are required before potential investors and entrepreneurs can make commercially informed decisions. The consensus view across the literature 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 and more challenging than generally envisaged in terms of processing capacity and costs. The weight of evidence suggests that growing hemp for seed and CBD oil is the most lucrative and likely commercially successful activity at present and that cultivar breeding for these two uses will become more profitable over time. At the end of the day, however, the future of the industrial hemp market is dependent on the type(s) of demand that will prevail and the crop's future sustainability. Cherney and Small (2016) consider three broad scenarios and timeframes to estimate the possible paths of a future industrial hemp industry (Figure 4).

Figure 4: Development path of a novel crop: industrial hemp



Source: author's construction based on Cherney and Small (2016).

The following sections consider the opportunities and constraints of the above discussion in the context of a possible South Africa–Malawi industrial hemp value chain. The proposition is considered because, according to government insiders, the Malawian government has just completed a two-year study into industrial hemp and is on the cusp of legalizing the cultivation of the crop. This, coupled with South Africa's strong industrial base and more specifically the recent move to change the scheduling of CBD oil, as well as the country's strong wellness market, suggests that value chain complementarity could be developed.

8 Malawian agriculture and policy

Malawi is a small landlocked country with a temperate climate and a population of 17 million (Government of Malawi 2018). Eighty-five per cent of the population live in rural areas. According to the Food and Agricultural Organization of the United Nations (FAO) (2015) and the World Bank (WB) (2014), Malawi is the fifth-poorest nation on earth, with a GDP per capita of just US$146. Half the population live below the poverty line, and 60 per cent of all children suffer acute or severe malnutrition. The country ranks 210th in the world in life expectancy and has the world's highest infant mortality rate.

The economy in 2018 was valued at just US$12.8 billion, of which agriculture accounted for 45 per cent, services 44 per cent, and industry 10 per cent. The industrial sector accounts for only 5 per cent of total national employment, 90 per cent of which is in the agricultural sector. This is dominated by the tobacco industry, which accounts for 13 per cent of total GDP, 70–90 per cent of average household income, 20 per cent of government revenue, 53 per cent of all commodity exports, and 70–90 per cent of national foreign exchange earnings (FAO 2015; Government of Malawi 2018; WB 2014). Malawi is the fifth-largest exporter of Burley tobacco globally and its annual output accounts for 6.6 per cent of global exports. The country's industrial sector is characterized by textiles, footwear, and clothing production and some agro-processing (mainly tea, sugar, and macadamia nuts). The manufacturing sector has been shrinking for the past decade, mainly due to extremely thin domestic markets, a shortage of skilled workers, and very high transport and trading costs. The WB ranked Malawi 172nd out of 183 for difficulties and costs associated with trading across borders and overall competitiveness. The World Economic Forum (WEF) ranked the country 134th out of 150 in its Global Competitiveness Report; the country scored just 2.6 out of 7 for product process sophistication (WEF 2015).

Malawi exports mainly unprocessed commodities—principally tea, sugar, and tobacco. Its main imports are fuel and fertilizer. The country has a substantial trade deficit with the Southern African Development Community (SADC) and the rest of the world. Donor aid and support is a major contributor to operating revenue for the government, accounting for 14 per cent of total revenue in 2018.

With the agricultural sector accounting for 90 per cent of national employment and 45 per cent of GDP, and in the context of very real food security issues, agricultural output is crucial to the Malawian economy and its people. Currently, tea and sugar tend to be grown on large estates, whereas the tobacco sector is dominated by small producer output. These small producers, who operate farms of 1–2.5 hectares, produce 95 per cent of the country's tobacco leaf. They grow maize for food and tobacco as a cash crop on a rotational basis. Since 1926, tobacco has been viewed as the 'king of crops' but its new pariah status on the back of global no-smoking campaigns and bans has made Malawi's dependence on the crop a source of concern, and led many commentators to suggest that alternatives be sought. One such alternative being advocated is industrial hemp.

Before looking at the potential of the Malawian government's likely economic and agricultural policies and the drive for agricultural crop diversification, it is necessary to understand the structure of the tobacco industry and the specific structural dimensions that have arisen and now affect the potential of Malawian smallholder farmers to shift to the production of alternative cash crops. As will become evident, these structural supply-side constraints will strongly impact the design of any potential collaborative industrial hemp value chain between Malawi and South Africa.

Malawi became a British colony in 1893 and tobacco was immediately introduced as an export crop. The tobacco variety grown was Burley—a relatively utilitarian tobacco leaf, which is still used as a filler in almost all cigarette brands today, but which does not achieve the highest tobacco prices in world markets. Initially, tobacco in Malawi was grown on vast estates owned by settlers. To ensure sufficient labour, sharecropping arrangements were instituted and estates granted a monopsony on the selling of tobacco, which meant that they could buy tobacco from their tenants at below market prices. At independence in 1964, President Hastings Banda supported the takeover of settler-owned tobacco (and sugar and tea) estates by the newly independent political elite and his family members. Between independence and the early 1990s, the Banda government allocated resources to assist these estates. Subsidized bank credit and inputs were made available, investment and capital equipment were provided through the Agricultural Ministry, and, most distortingly, the Agricultural Board decreased the prices of other agricultural crops, forcing independent peasant farmers into low-wage employment on the tobacco estates. In addition, the government set up an auction system with the state-run Agricultural Board as the only authorized seller of tobacco in the country. In this way the state supported the price and profitability of the tobacco sector, but ensured that the benefits were enjoyed only by a small number of the political elite, at the expense of the poor. The structure of the agricultural sector meant that systemic food shortages persisted.

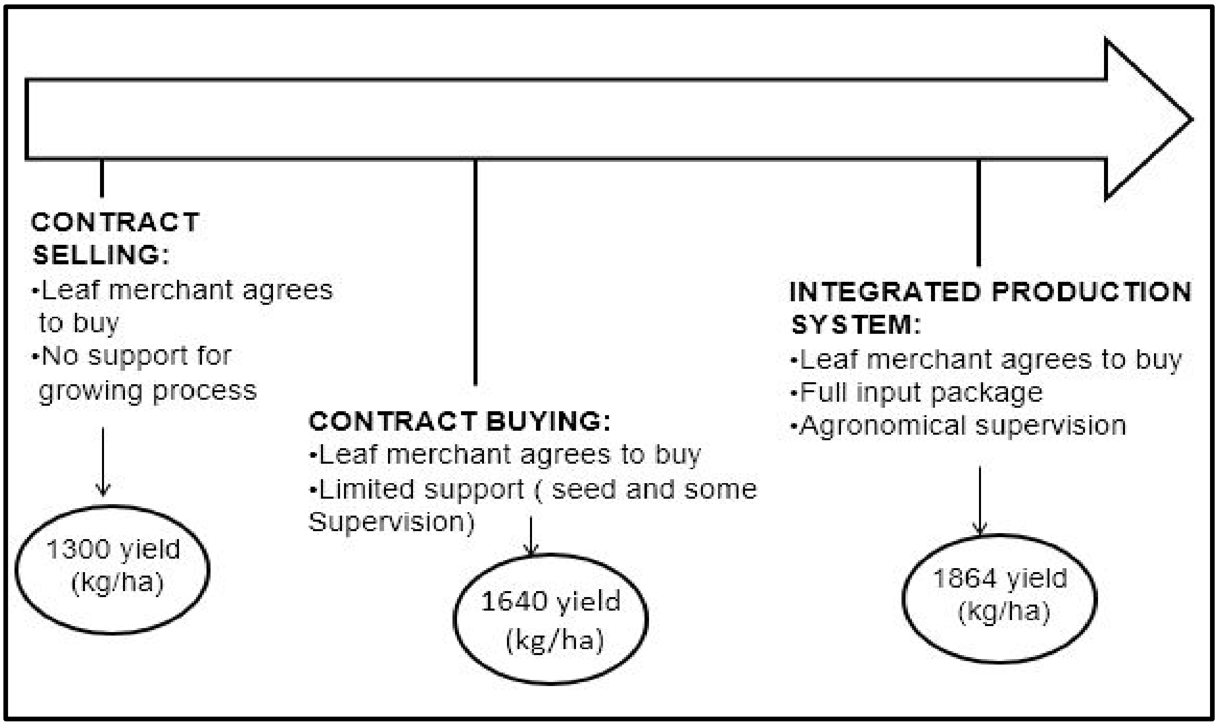
In 1993, a referendum on multi-party democracy was held. The winning party in the first election came to power on a market-orientated platform that included privatization and trade liberalization. The number one issue facing the government was food security. The immediate policy response was that the food crisis was solvable through the cultivation of cash crops in rural areas. Burley tobacco was seen as the most profitable cash crop and hence a policy began to encourage smallholding farmers (with farms of less than 2 hectares) to grow Burley tobacco. The WB, FAO, and United States Agency for International Development (USAID) all supported market liberalization, and some structural adjustments were in fact made conditions for future financial aid. On the back of these policy reforms, the number of smallholding farmers grew from just 7,500 in 1990 to 400,000 in 1997; and their output of Burley tobacco increased from 2.26 million tons to 30 million tons. By 2001, smallholder production of Burley tobacco had risen from 10 per cent of total output to 70 per cent, and the structure of the supply side of the agricultural sector altered fundamentally.

While the supply side enjoyed some liberalization and restructuring, the market system by which tobacco was sold and prices realized remained highly interventionist (and hence open to corruption and abuse). For example, the government set wage rates and restricted the seed types made available to farmers and how they could move their final crops. On the market side, smallholders were still not allowed to sell at auction on a private basis. Crops had to be sold to the state-owned agricultural board, which then sold the leaf at auction to international buyers. Because the agricultural board only passed the proceeds of the sale onto the farmers after all levies and fees had been deducted, and when all negotiations had been completed, cash-strapped farmers who needed to purchase inputs for the next crop often accepted lower US$ prices for their crop in return for a faster pay-out.

In this system the volume, but especially the quality of tobacco produced by smallholders, decreased as farmers used fewer inputs because of their limited cash available to buy pesticides, herbicides, and fertilizers. As tobacco is an input-intensive crop, prices and yields plummeted, as did revenues and profitability. This led to yet another restructuring of the sector and the introduction of the leaf buyer-driven Integrated Production System (IPS), by which the tobacco buyers (five companies buy 100 per cent of Malawi's production) embarked on a system of process upgrading of the value chain to ensure that they were supplied with traceable and compliant tobacco of the required quality.

Essentially, in modern Malawi there are three ways that tobacco is sold, as shown in Figure 5. The majority of smallholders (80 per cent) enter into IPS agreements with the leaf buyers, as they can achieve higher yields and obtain higher prices.

Figure 5: Contracting arrangements for tobacco



Source: author's construction based on Moyer-Lee (2013).

The IPS package is substantial and multifaceted. For the tobacco crop, fertilizer, seed, pesticides, plastic sheeting, and baling string are provided. The package also includes 12 kg of maize seed and 150 kg of maize fertilizer. This is to ensure food security, recognizing that tobacco is grown as a rotation crop only, maize being the dominant crop, cultivated for household consumption. Finally, the IPS package includes tree seedlings to offset the deforestation required for tobacco farming. The package is all-inclusive, and farmers cannot pick and choose items from the offering. Drope et al. (2016) calculated that in 2015 the total package had an average value of around US$950. This represents a higher than market price for the inputs provided, but since most farmers do not have access to markets or cash, and since the leaf buyers offer no flexibility on the package, smallholders are forced to accept these higher-priced inputs. The leaf companies organize all transport of the crop and payment is made only after all input costs have been covered. Smallholders therefore have to wait around eight months to realize the revenue from their crop, although most leaf companies provide cash advances to the farmers as a means of preventing side selling.

The Malawian government negotiates minimum tobacco prices with the leaf companies in an attempt to protect smallholders from exploitation, as the five buying companies operate like a monopsony, with substantial collusion. Drope et al. (2016), Johansson (2011), and Moyer-Lee (2013) all agree, however, that the leaf companies are manipulating both their contract farmers and government officials. On the contract farming side, both the government and international donors are educating farmers about an impending decrease in demand for tobacco in first world countries and the risk of remaining reliant on such a pariah crop. The leaf growers counter this argument by telling farmers of increasing tobacco demand in developing countries and hence stable overall demand and pricing moving forward. Simultaneously, the leaf companies tell the government that sales of cigarettes are declining and hence market demand for tobacco is falling in order to negotiate lower minimum prices for leaf. As a result, there are mixed messages around shifting to alternative cash crops.

The government is currently looking at crop diversification, but what must be borne in mind is that smallholders in Malawi who are cultivating tobacco as their dominant cash crop have no experience or skills in growing and selling in a free market system. The structure of the agricultural sector in Malawi has created farmers who are largely reliant on input packages and substantial agronomic support during the germination, planting, growing, and harvesting stages of their crops. They are also used to having selling contracts in place and receiving interim cash advances prior to the value of the crop being realized. These realities are perpetuated in current government and WB and FAO policy in the country and result in a 'dependent' or 'tied' farmer economy. In an ethnographic study of the adaptability of smallholder tobacco farmers in Malawi, Milanzi (2017) goes so far as to accuse the leaf companies of portraying themselves as NGOs to the farmers, and both the leaf companies and the government of being paternalistic towards the smallholder farming sector. As a result, the decision to shift from tobacco to an alternative cash crop such as industrial hemp would depend not only on the net profit achievable per acre but also on the amount and structure of support forthcoming to support such a shift.

9 Potential for a Malawian–South African value chain in industrial hemp

We are now in a position to consider the possibilities and potential for the development of an inter-regional value chain in industrial hemp between Malawi and South Africa. What has emerged is that, from a purely agronomical viewpoint, cultivating industrial hemp, using the know-how and experience of smallholder tobacco farmers in rural Malawi, is achievable. Depending on the end use chosen, the margins per acre achievable with this alternative rotational crop suggest that, in the face of likely pressure on tobacco prices caused by decreases in demand, diversification into industrial hemp would be commercially viable for smallholders. The credentials of the crop in terms of required inputs and impact on soil also suggest that, environmentally, the crop would be superior to tobacco. However, given the structure and history of smallholder agriculture in Malawi, a shift to industrial hemp as an agricultural commodity would need to take place within a system of value chain upgrading and support, as well as contract buying or offtake agreements. Despite Malawian ambitions to add value to commodity crops, current industrial capacity and investment constraints suggest that at present the country would be limited to the primary processing of post-harvest industrial hemp, and that secondary processing would need to be undertaken in a country with greater processing capabilities.

On the beneficiation side, the present research establishes clearly that South Africa has the processing knowledge and capability to produce the end uses of industrial hemp shown to be most profitable. Not only does the country have existing relevant knowledge, capacity, and capability; it is also actively undertaking R&D in production processing and alternative uses for industrial hemp.

For example, the Council for Scientific and Industrial Research (CSIR) is undertaking research into natural fibre and bio-composites and there are multiple private sector initiatives in the production of industrial hemp essential oils and supplement development. Less clear is the likely level of South African market demand for certain key industrial hemp end products. Demand is presently niche but this may be due to limited supply and marketing. This need not be an industry development constraint, however, as South Africa could export value-added hemp products to global markets.

This section begins by looking at the potential supply side of industrial hemp production in Malawi, followed by an overview of South African capabilities for value addition on downstream industrial hemp products. The section concludes by looking at existing constraints and risks and the additional research required if this opportunity is to be pursued.

9.1 Upstream cultivation

In 1998, the Malawian government adopted the Malawi Vision 2020—a compendium of policies and framework documents aimed at guiding the country to higher growth and development levels, with agriculture and food security as priority areas in all aspects. Part of the Vision is the Malawi Growth and Development Strategy, which seeks to reduce poverty through sustainable economic growth and infrastructure development, driven by an increase in agricultural productivity and diversification. This is backed up by the National Export Strategy, which seeks to boost domestic and external trade by increasing (among other things) the diversification and volume of agricultural exports through the empowerment of farmers, and, more specifically, the Agriculture Sector Wide Approach (ASWAp). Since 2005 most of the ASWAp budget has been allocated to the farm input subsidy programme (FISP). This provides input subsidies in the form of vouchers and coupons to small-scale farmers, with which they can purchase seed, fertilizers, and pesticides. The FAO calculates that in 2015, 80 per cent of small farmers received such vouchers and that FISP accounted for 75 per cent of the total ASWAp budget (FAO 2015). Over the years, the government has made FISP support available for different crops in an attempt to support cash crop diversification. For example, in 2010 a legume support package was introduced, and in 2012 a bird's eye chili support programme.

These policies 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. Indeed one of the arguments made in the submission to the government in support of the legalization and deregulation of industrial hemp as an alternative cash crop was that industrial hemp requires lower levels of inputs (especially herbicides, pesticides, and to some extent fertilizers) than tobacco, which is a high-input-requirement sector. Industrial hemp would therefore be not only a farmer-friendly crop but also a government-friendly support alternative, as it would decrease absolute and relative resources required through the FISP. In addition, because industrial hemp can be successfully grown using natural rainfall, the limited fiscal resources earmarked for irrigation for small farms could be focused on maize production and hence improve food security. It can be concluded, therefore, that a policy or programme to develop industrial hemp as an alternative cash crop in Malawi would be consistent with the economic and agricultural sector goals and ambitions of the Malawi Vision 2020. In addition, support programming is in place to allow such a shift using existing outreach, extension service, and input subsidization programming.

Drope et. al (2016) undertook a farm-level study of small-scale tobacco farmers in Malawi and asked survey participants what it would take for them to switch from tobacco to an alternative rotation cash crop. The responses are shown in Table 10.

Table 10: Small-farmer survey: drivers of decision to switch cash crops (per cent respondents)

	Independent farmers	Contract farmers	All
Reliable market for alternative crop	57	55	56
Adequate capital	8	9	8
Adequate access to inputs	7	6	7
Viable alternative cash crop	19	23	21
Others	10	7	9

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

Of greatest concern to farmers is whether there are reliable, predictable, and stable markets for their harvests. Given that agricultural commodity markets are not liberalized in the economy, and that 80 per cent of farmers are currently involved in an integrated production system (IPS), farmers would require 'certainty' of, or at a minimum a very high level of confidence in, reasonable prices and stable sales to switch from their current safe crop of tobacco. Drope et al. (2016) find that smallholders are tolerant of some price variation, but that the risk of total crop failure or total failure to find a buyer is unacceptable. Because of existing low levels of capital intensity and the long-term existence of input supply packages supported by donors and the government, adequate capital and access to inputs are not viewed as major obstacles to crop diversification. The case studies examined earlier in Canada, Australia, and the US all suggest that, given the thinness of existing markets, farmers of industrial hemp will establish upfront purchase undertakings or offtake agreements, even in these relatively developed markets. 90 per cent of Canadian seed growers have offtake agreements and in Australia the regulation of industrial hemp cultivation licences requires that an offtake agreement for 100 per cent of the harvested crop be signed before the licence is granted. As the IPS is a form of offtake agreement, the current Malawian IPS would fit well with existing international market practice and experience.

The industrial hemp cultivation licensed by the Ministry of Agriculture in 2015 used certified imported seeds. These were successfully germinated and cultivated to harvest using limited inputs and rain-fed growing techniques. Thus, from an agronomical perspective, industrial hemp crop cultivation has proved successful.

Furthermore, interviews with study participants suggest that existing tobacco growing and harvesting techniques and know-how are transferable and applicable to industrial hemp. Although not reported on by the trial participants, it appears that the low-capital, hand-based harvesting of an industrial hemp crop would be beneficial to yields if the crop was grown for the purpose of seed.

Finally, in terms of the viability of industrial hemp as an alternate crop, the final estimations of the margin or yield per hectare (as calculated in the studies completed on behalf of the Ministry of Agriculture) have not yet been made public. However, using estimates from the case studies above, and calculated margins for Malawi's top four cash crops cited in Drope et al. (2016), the assessment looks positive (Table 11).

Table 11: Cash crop margins per acre (US$)

Cash crop	Margin per acre
Soya bean	123
Paprika	31
Bird's eye chili	209
Tobacco (independent grower)	37
Tobacco (contract grower)	224
Industrial hemp seed	360
Industrial hemp CBD oil	3,000*
Industrial hemp fibre	184*

*Author's calculations. Margins are calculated including labour costs, although most Malawian small farmers use unpaid family labour, hence the real return is underestimated.

Source: authors' construction based on Drope et al. (2016); Fortenbery (2014).

Industrial hemp potentially provides a highly profitable alternative cash crop if it is grown for the production of CBD oil or hemp seed, or, as shown earlier, as a dual crop for seed and oil. When researching Malawi-based companies that were gearing up for the processing of an industrial hemp crop, such as Invegro (the lead private sector lobbyist for industrial hemp, and trial licence holder), I found that the plant uses being considered are broad and include: hemp seed oil (but not CBD), hemp protein powder made from the residual of seedcake, hurd for the production of construction materials, and essential oil production. The seed market was not identified as a major market opportunity, which appears to be a substantial oversight given current markets and traded volumes. It may, however, be a response to the fact that current harvesting and storage practices of Malawian tobacco farmers would not be adequate to meet the Good Agricultural Practices (GAP), Good Storage Practices, and Good Harvesting Practices required by developed country markets for the production of a foodstuff for human consumption. Upgrading would be required.

Although Invegro plans to undertake value-adding processing of industrial hemp, it currently has no production facilities and insufficient capital to invest in such activity. Data and information on the industrial sector and production capacity in Malawi are hard to find. From Trade Map (n.d.), it appears that out of a US$29 million crop of oil seed only US$50,000 was value-added processed output. Moreover, the data suggest that none of this added value was accounted for by oil extraction but rather by lower-value-adding flours and meals produced by basic grinding. Similar patterns are found with wood and cotton output, supporting the finding that the processing sector in Malawi is small and declining and that the country is an unprocessed commodity exporter. In addition, from the research it appears that few of Malawi's existing agro-processing facilities meet GMP, the international standard for the preparation of foods for human consumption (FAO 2015; WEF 2015; World Bank 2014).

This suggests that Malawi's potential comparative advantage lies in the low-cost production of industrial hemp. Given this reality and the structure of the agricultural sector, it appears that the most practical and commercially feasible option for the development of a Malawian industrial hemp sector would be for external contract buyers to purchase unprocessed industrial hemp from Malawi and undertake beneficiation of the product into various uses in countries with existing processing capacity. In time, if industrial development of the processing sector is successful under the Malawi 2020 Vision, value-adding activities could be clawed back into the domestic Malawian market.

The big complication, as alluded to in earlier sections, is that to ensure commercial viability, the end use of industrial hemp needs to be determined upfront so that the seed choice, planting densities, and inputs are optimized to provide the required plant characteristics. In other words, any industrial hemp crop grown in Malawi would need to be for a specific purpose. The tobacco leaf companies have demonstrated how value chain upgrading and support measures have allowed contract farmers to move up the value chain to produce the quality leaf output the market requires. There is no reason not to assume that a similar process could be undertaken for industrial hemp, although one potential contract buyer in South Africa did raise concerns about the resources that would be necessary for industrial hemp farmers to meet GAP standards if the crop were to be used for human food preparations and oil consumption.

9.2 Downstream processing

Turning to downstream value-adding activities along the industrial hemp value chain, South Africa has capacity and capabilities in almost all activities related to potential industrial hemp end uses. Quantifying or even gauging demand, however, is difficult, given a lack of official data and the limited current product offering due to restrictive regulations.

Legislation in South Africa pertaining to industrial hemp and downstream product manufacture is fragmented, highly complex, and rapidly changing given the current reconsideration of the regulation of medical cannabis and especially CBD products.

With regard to the cultivation of industrial hemp, the South African government has not yet made a legislative distinction between the two varieties of Cannabis sativa: namely, industrial hemp and its narcotic cousin, marijuana. The Cannabis sativa plant itself is classified as a Schedule 7 drug under the Medicines and Related Substances Act 101 of 1965 and as a narcotic in the Drugs and Trafficking Act 104 of 1992. It is illegal to commercially cultivate industrial hemp in South Africa except in small quantities for research purposes under licence from the government and in accordance with detailed regulations stipulated by the South African Health Products Regulatory Authority (SAHPRA). These regulations are so onerous that compliance costs would render any output commercially unviable even if larger-scale cultivation licences were allowed. In Parliament in April 2019, the then Minister of the Department of Agriculture, Forestry and Fisheries (DAFF), Senzeni Zokwana, stated that DAFF, the Department of Health, and the Department of Trade and Industry were looking into the feasibility of the commercial cultivation of industrial hemp. However, industry lobbyists, players, and members of the National Hemp Association, believe that after 15 years of lobbying and lukewarm government responses it is unlikely that legislative changes will take place soon. As a result, any downstream processing of industrial hemp at a commercial scale (mass market or even niche market) would, at least initially, need to be based on imported industrial hemp feedstock.

The legislation covering the importation of industrial hemp in various forms is fragmented, and it appears as though gaps exist in the legislation (or that there is uncertainty in the market in the understanding of such regulations). Indeed, through the interview process many market participants revealed that they were unsure as to the legality of their imports or where relevant regulations existed. What is clear is that it is legal to import raw industrial hemp fibres into South Africa without permission or licensing being required. Such imports are covered by Customs and Excise Chapter 53 pertaining to 'other vegetable textile fibres, paper yarn and woven fabrics of paper yarn'. According to this, hemp (raw or processed but not spun), tow, and waste of true hemp (including yarn waste and garneted stock) may be imported. This means that any downstream production based on fibres such as weaving fabrics, making apparel or ropes, or producing bio-composites or green substitute building materials could be supported by importing fibre (which has been retted, with the bast fibres separated) from Malawi.

Regarding the importation of non-fibre portions of the plant, the relevant legislation appears to be in the listed exceptions to Schedule 7 of Section 22 of the Medicines and Related Substances

Act 1965, which states that the 'whole cannabis plant or any portion or product thereof' is prohibited except:

> (b) processed[5] hemp fibre containing 0.1 percent or less of tetrahydrocannabinols [THCs] and products manufactured from such fibre, provided that the product does not contain whole cannabis seeds and is in a form not suitable for ingestion, smoking or inhaling purposes; or
>
> (c) processed product made from cannabis seeds containing not more than 10 milligrams per kilogram of THC and [not containing] whole cannabis seeds; or
>
> (d) [when used] in hemp seed oil containing 10 milligrams per kilogram or less of tetrahydrocannabinols, when labelled 'Not to be taken' or 'Not for internal human use'; or
>
> (e) [when used] in products for purposes other than internal human use containing 10 milligrams per kilogram or less of tetrahydrocannabinols. (SAHPRA 2017: 133)

From the above, it appears that as long as industrial hemp feedstock meets the minimum THC levels (which are low at 0.1 per cent versus the American and EU levels of 0.3 per cent and 0.2 per cent, respectively) it may be imported for further processing.

The status of whole-seed importation and the use of hemp oil for human ingestion is unclear and is currently being investigated by the DoH and SAHPRA, but both products are readily available on retail shelves at present and importers advise no problems to date with such imports. This suggests that feedstock could definitely be imported for the extraction of essential oils or oils to be used in personal care and cosmetic products, or stalks for bio-energy use, hurds for bedding, and/or seedcake to be used as animal feed. The legality of importation for use as an input to process foodstuffs for humans is similarly unclear.

Finally, the issue of regulations for CBD oil must be considered, given the margins that appear to be achievable for this end use of the industrial hemp crop. Currently, if the end-use CBD product makes medical claims, it must be registered with SAHPRA as a medicine and can be dispensed legally as a Schedule 4 drug (prescribed by a doctor). At present, none of the CBD products freely available on the South African market is registered with SAHPRA and SAHPRA claims that it has no applications pending for such a registration. This means that all current CBD products making medical claims (anti-nausea, arthritis, pain relief, lowering blood pressure, anti-seizure, sleep aid, etc.) are being illegally sold in South Africa, although enforcement is weak, given that there are only five SAHPRA inspectors responsible for compliance. In relation to CBD oil products on the market that do not make medical claims—for example, products marketed as health or food supplements—neither SAHPRA nor the Department of Health (DoH) has issued any standards or guidelines to ensure quality, safety, or informational transparency for consumers. This is seen as a major problem, given the popularity of CBD oil and the size of the informal market that has developed. SAHPRA and DoH are currently drafting such standards and guidelines.

In sum, although additional clarity is required with regard to the legality of importing seed for human consumption and to the required standards for CBD oil sold without medical claims, it appears as though it would be legally possible to import industrial hemp feedstock from Malawi for further downstream processing in South Africa. It is worth noting that many South African

---

[5] I.e. treated by mechanical, chemical, or other artificial means.

companies are importing seed for human consumption and hemp-based health supplement products without objections from customs or health authorities to date (Coogan 2016).

Downstream processing capability and capacity in South Africa vary across different uses of industrial hemp. Fortunately, however, 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 greatest potential to grow. The majority of industrial hemp processing is categorized as either agro-processing or chemical processing. The Standard Industrial Classification (SIC) code for agro-processing covers food products (including animal feed as well as food for human consumption), beverages, tobacco, textiles (including ropes, canvas, and tarps), wearing apparel, leather and leather products, footwear, paper and paper products, wood and wood products (including particle board made from natural fibres), rubber, and furniture. The use of industrial hemp in the manufacture of personal care and 'health' products is included in three subsections of the chemical SIC codes and includes: the production of soaps, detergents, cleaning and polishing preparations, perfumes, cosmetics, and other toilet preparations; pharmaceuticals, medicinal chemicals, and botanical products; and 'other chemicals', which covers the extraction of essential oils.

South Africa's downstream processing capacity and capabilities are weakest in textile manufacture. This sector has been strongly negatively affected by cheap import leakages and a failure to produce cost-competitive output for export. The import to domestic production ratio in 2016 was as high as 37 per cent and sectoral real gross domestic fixed investment (GDFI) has been declining consistently over the last decade. In 2015, GDFI contracted by 11 per cent and in 2016 by a further 15 per cent. Leakages and low demand for domestically produced items have resulted in capacity utilization rates of just 65 per cent, suggesting that on paper spare capacity exists. Textile plant is, however, old and not set up to work with natural fibres, although the CSIR has been undertaking R&D to adapt cotton-based processing equipment for natural hemp processing. Overall, the assessment is negative: that South Africa could not become an industrial hemp textile producer without substantial capital and R&D investment. Even if such investments were forthcoming, it is unlikely that South Africa would be able to compete with China and India in the sector. Thus, except for a small artisanal textile sector, this particular use of industrial hemp is probably not an area of value addition that the South African economy could capitalize on.

The picture is fundamentally different when it comes to food preparation, health food, and wellness products, and the production of cosmetics and personal care products.

The food production industry in South Africa has faced difficult market conditions over the past five years. The industry is dominated by half a dozen large companies, is highly technologically advanced, and complies with all international standards and quality control systems such as GMP. The industry is currently struggling with increased input prices (driven by increases in the price of farm inputs such as diesel and fertilizers, which escalated by 9.3 per cent in 2016) and low levels of demand due to high pressure on consumers from increases in utilities and fuel prices. As a result, the country's spare food processing capacity has risen to 18 per cent. Because industrial hemp food products are such a niche market in South Africa, none of the large producers currently processes any, but interviews with two companies suggested that if the products became mainstream there would be no problem producing seed, oil, flours, pastes, and meals from the inputs supplied post-harvest at a commercial scale.

According to a survey by IRI, South African food consumers are at the forefront of 'healthy' shopping. The survey indicates that 75 per cent of South African shoppers buy healthy and organic foods compared with 70 per cent of EU consumers; 24 per cent buy their health food products from specialist health food stores, 16 per cent from pharmacies, and 6 per cent online

(Bizcommunity 2017). The country's five largest retailers also list health foods and speciality health products as growing market items. The current speciality health food market, however, remains small in absolute value and market share terms and is predominantly serviced by specialist micro or small companies. Although the survey was limited to 3,500 shoppers, the picture that emerges is that the majority of current domestic demand is met by small producers who import finished products in bulk and then use GMP contract packing companies to produce retail-sized, appropriately branded finished stock, which is sold through retailers. Only four companies were found to be undertaking any value-adding processing of hemp products for human consumption, but numerous other companies with appropriate processing capacity were identified (for example, Future Life, which operates a GMP-compliant manufacturing facility producing energy foods, high-protein foods, and speciality health products). These companies are medium-sized but could scale up if demand required it. Therefore, South Africa has the current capacity to service a (growing) niche market, as well as the potential to service a mainstream commercial-scale market for industrial hemp food preparation for human consumption.

Perhaps the greatest opportunity for using spare capacity in the South African industrial structure relates to the production of industrial hemp-based nutraceuticals and dietary supplements and tablets. This opportunity exists for two reasons. The first is that South Africa (because of its biodiversity) has always had a large number of world-class herbal, homeopathic, and natural plant-based personal care product and therapy producers. These producers are highly innovative, invest substantially in R&D and new product development, and sell into niche markets that impose strict quality control standards. The country is home to several natural health brands that are globally recognized over and above their strong domestic performance. These companies, such as Buchulife, Vitaforce, Natura, Floraforce, and Weleda, are all medium or large businesses (100–200 employees) and all operate GMP-compliant manufacturing facilities, in-house quality control and laboratory services, and state-of-the-art packaging facilities. Because of strong in-house knowledge and skillsets, all feel confident that they could increase in scale if demand required it and believe that the only constraint would be access to capital. The second reason is the large opportunity in this subsector for mainstreaming commercial production at a very large scale. In recent years, South Africa-based pharmaceutical companies have switched from local production to importing final products. As a result, several state-of-the-art pharmaceutical processing facilities have been either mothballed or sold to entrepreneurs, who are now running the capital equipment on a contract manufacturing basis. Their spare capacity could be utilized to mass-produce industrial hemp health supplement tablets, capsules, oils, or tinctures. Thus, South Africa could produce at multiple scales if an international hemp product market grows in this particular subsector.

There is also the issue of CBD oil. As explained above, 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. Current demand for CBD oil from industrial hemp is therefore relatively weak, and if marijuana legislation and regulation are relaxed (as seems to be the global trend) demand for industrial hemp CBD oil will all but disappear. It is unlikely that any large-scale investment will be forthcoming to produce this product despite current short-term demand and a price bubble. In the South African context, no CBD oil production is licensed or registered under current SAHPRA guidelines or the relevant legislation. Technically, any CBD oil that makes medical claims is in the market illegally and the authorities are committed to prosecuting manufacturers and suppliers of such products. CBD oil on the market that does not make medical claims is legal but there are no standards available to control purity, concentration, or quality. Indeed, most products currently on the market at retail stores are produced in individuals' garages and kitchens using crude manual production processes and no quality control or concentration verification. If feedstock were readily available, the nutraceutical companies listed above might start producing CBD oil using their current solvent-based extraction facilities, and the resulting product would meet the safety and disclosure requirements soon to be set out and published by SAHPRA and the DoH. It therefore appears that South African firms could use existing capacity, know-how, and technology to produce niche market quantities of CBD oil. Mass production would probably not be supported, as the required investment would be viewed as too risky given the possible consequences of future relaxation of restrictions on marijuana cultivation and sale.

Finally, with regard to other innovative uses of industrial hemp (e.g. as an alternative insulation material, in bio-composites, and in organic paint production), it is hard to assess South Africa's capacity to produce such goods given that not even niche markets exist. From talking to the experts operating the natural fibres research division at the CSIR, it appears that substantial R&D is being carried out on alternative uses and processing technologies. This means that if industrial hemp were to become a mainstream agricultural commodity with mainstream market acceptance and demand, South Africa would already have a core knowledge base and therefore be well positioned to take advantage of several new opportunities. Work on bio-composites is particularly advanced.

All of these opportunities obviously require a reliable supply chain of cost-competitive raw and semi-processed inputs and feedstock, which raises a final point regarding the price of industrial hemp feedstock imported into South Africa for further processing. Cherney and Small (2016), Crawford et al. (2012), and Fortenbery (2014) all note that industrial hemp immediately post-harvest is a highly bulky crop; though it has a low weight, it has a high volume profile as a product to be transported. They therefore suggest that hemp should be cultivated close to processing sites so that transport costs are minimized. They claim that transport costs to less proximate processing facilities will impact the commercial feasibility and final selling price of end-use products, but in no studies were transport costs or logistics actually calculated or taken into account. Given Sub-Saharan Africa's abysmal performance in controlling transport costs and overcoming logistics inefficiencies between SADC members (Lowitt 2017; Vilakazi and Paelo 2017), moving unprocessed industrial hemp feedstock from Malawi to South Africa may result in landed input costs that undermine the competitiveness of the value chain.

10 Conclusion

Despite industrial hemp having been cultivated as early as 8000 BC in Mesopotamia and being the largest and most ubiquitous agricultural crop across Europe and the Americas from the 16th to the 19th century, its non-cultivation (outside China) for the past 50 years has meant that if it were to be revived as an agricultural crop it would enter the market as a novel crop. All novel crops face agronomic, economic, processing, market, and social/political challenges.[6] Agronomically, if industrial hemp were to become a mainstream agricultural crop, more productive cultivars and cultivars fit for a dual crop purpose would need to be developed at scale. In addition, better understanding of input requirements and crop management would need to be developed to support scaled-up cultivation in a commercially viable manner.

With regard to processing capacity and capabilities, while some processing knowledge, know-how, and capital equipment can be brought to bear and repurposed for the development of a novel crop, in many instances processing capacity and development are themselves a limiting factor. This is abundantly true of industrial hemp. For example, the Canadian authorities say that one of the reasons for limiting licences for industrial hemp cultivation is the shortage of processing capacity.

[6] See Cherney and Small (2016) for a summary of the history of novel crops in America over the past 30 years.

They also note that the failure of private companies (and especially multinational corporations) to invest in the sector suggests that the crop is likely to remain a novel, niche-market crop in the near future. Other authors argue that, as R&D occurs in the sector and harvesting and processing capital equipment and production processes improve, so the profitability of the crop will increase, allowing additional market expansion.

What is abundantly clear is that the most important single contributor to the success or failure of a novel crop is market demand (which in the case of industrial hemp is strongly influenced by social and political issues). 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 health food properties of the product and its therapeutic uses as an oil and as an input in personal care and cosmetics. There appears to be a shared view that if industrial hemp is to become a mainstream, large-scale, commercially cultivated crop at a global level, 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 that the market for industrial hemp products and downstream processed products is niche, with thin markets and low traded volumes. Whether this will change is hard to predict.

As Cherney and Small (2016) point out, a novel crop takes about 12 years to become embedded in an economy. During these growth years, the balance between supply and demand is crucial. In the event of mass cultivation without the commensurate increase in end market demand, farmers will see prices tumbling and cultivation will rapidly become commercially unviable, resulting in a switch away 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; and without stable end markets the establishment of processing plants will stall. The risks to be faced by any early movers at scale are therefore considerable.

Against this background, however, there is an undeniable opportunity for industrial hemp to become a niche product and for a future industrial hemp value chain between South Africa and Malawi to be based on servicing such a niche market. If global demand subsequently expands, then early adoption and entry into the value chain will put South African and Malawian participants in an advantageous position. Even if the market is not scaled up, the niche market opportunities will remain and are sustainable as a source of cash crop diversification in Malawi and new product range manufacturing opportunities for South Africa. The research suggests that the most viable and strongest 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, the production of CBD oil is likely to be the most lucrative in the short term. Although this issue has not been highlighted in the research, work by Lowitt (2018) on medical cannabis in South Africa raises the 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, as happened with insulin. This suggests that the CBD market sourced from natural plant materials may not be sustainable in the medium to long run. The market for hemp as a foodstuff, however, remains sustainable, as does the market for essential oils.

This initial research effort suggests that if the Malawian Parliament votes to legalize the cultivation of industrial hemp (as is expected), then the opportunity to develop a regional value chain between that country and South Africa has interesting and potentially positive commercial implications. Additional research and quantification would be required in relation to designated crop yields, South African market demand, and transport costs, but preliminary findings suggest that industrial hemp would indeed be a profitable and potentially strategic diversification for both states. If and when the legislative constraints on cultivation are lifted, challenges will remain to implement such a value chain, but no challenges have been identified that would not in principle be solvable.

References

Amaducci, S., D. Scordia, F.H. Liu, Q. Zang, H. Guo, G. Testa, and S. Cosentino (2015). 'Key cultivation techniques for hemp in Europe and China'. *Industrial Crops and Products*, 68(July): 2–16.

Bizcommunity (2017). 'SA shoppers' penchant for healthy, organic food an opportunity for brands'. *Bizcommunity*. Available at: https://www.bizcommunity.com/Article/196/168/170915.html (published 5 December 2017).

Cherney, J.H., and E. Small (2016). 'Industrial hemp in North America: Production, politics and potential'. *Agronomy*, 6: 2–24.

Cherrett, N., J. Barret, and A. Clemett (2005). 'Ecological footprint and water analysis of cotton, hemp and polyester'. Report prepared for Bio Regional Development Group and WWF Cymru, Stockholm Environmental Institute.

Coogan, J. (2016). 'The SA hemp story: Saviour crop or business as usual?'. Submitted as PhD Thesis at University of Stellenbosch, March.

Crawford, F., B. Deards, B. Moir, and N. Thompson (2012). 'Human consumption of hemp seed: Prospects for Australian production'. Department of Agriculture, Fisheries and Forestry, Australian Government, Canberra.

CRS (2018). *Hemp as an Agricultural Commodity*. Author: name redacted. Washington, D.C.: Congressional Research Services. Available at: https://www.everycrsreport.com/files/20180622_RL32725_c276fc644a1629238199b60e4c744d9f06260a33.pdf (accessed February 2020).

Dietz, J. (2013). 'Hemp is making money for Canadian growers'. Available at: www.agannex.com/field-crops/hemp-is-making-money-for-canadiangrowers (accessed 31 January 2020).

EIHA (European Industrial Hemp Association) (2018). 'Cannabis as a traditional food source'. Novel Food Working Group, Brussels. Available at: https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20(EIHA).pdf (accessed 31 January 2020).

Drope, J., D. Makoka, R. Lenucha, and A. Appau (2016). 'Farm level economics of tobacco production in Malawi'. Centre for Agricultural Research and Development, Lilongwe University of Agriculture and Natural Resources.

FAO (Food and Agricultural Organization of the United Nations) (2015). *Country Fact Sheet on Food and Agricultural Policy Trends*. FAO Malawi Office, Lilongwe, Malawi.

Fortenbery, T.R. (2014). 'Industrial hemp: Opportunities and challenges for Washington'. Working Paper 10. Washington State University.

Government of Malawi (2018). *Statistical Yearbook 2018*. National Statistical Office, Government of Malawi, Lilongwe.

Heister, S. (2008). 'Environmental costs of hemp prohibition in the United States'. *Journal of Industrial Hemp*, 13(2): 157–70.

Hemp Industries Association (n.d.). https://www.thehia.org.

Ingrao, C., A. La Giudice, J. Bacenetti, and C. Tricase (2017). *Energy and Environmental Assessment of Industrial Hemp for Building Applications: A Review*. University of Foggia, Italy.

Johansson, M. (2011). *Development from Tobacco? A Study of the Malawian Tobacco Industry and Its Impacts on Sustainable Development in Malawi*. University of Uppsala.

Johnson, R. (2018). 'Hemp as an agricultural commodity'. US Congressional Research Service, Washington.

Lowitt, S. (2017). *Cross-Cutting Logistics Issues Undermining Regional Integration across SADC*. Trade & Industrial Policy Strategies, Pretoria.

Lowitt, S. (2018). 'Medical cannabis study'. Prepared for the Department of Trade and Industry, Government of South Africa by Trade & Industrial Policy Strategies. Unpublished.

Milanzi, T.S. (2017). 'Living on the edge: Smallholder growers' responses to a changing tobacco economy in Malawi'. Submitted as a dissertation to the Department of Anthropology, University of Kentucky.

Moyer-Lee, J. (2013). 'Agricultural global value chain: The case of tobacco in Malawi'. Submitted as a PhD thesis, School of Oriental and African Studies, University of London.

Nyale, E. (2018). 'House allows industrial hemp bill drafting'. *The Nation Newspaper*. Available at: https://mwnation.com/house-allows-industrial-hemp-bill-drafting/ (accessed 29 January 2020).

Prade, T., S. Svensson, A. Andersson, and J.E. Mattsson (2011). 'Biomass and energy yield of industrial hemp grown for biogas and solid fuel'. *Biomass and Bioenergy*, 35(7): 3040–49.

Robbins, L., W. Snell, G. Halion, L. Maynard, C. Dillon, and D. Spalding (2013). 'Economic considerations for growing industrial hemp: Implications for Kentucky's farmers and agricultural economics'. University of Kentucky.

SAHPRA (South African Health Product Regulatory Authority) (2017). *Medicines and Related Substances Act 101 of 1965*. Available at: https://sahpra.org.za/wp-content/uploads/2019/09/Medicines-and-Related-Substances-Act_101-of-1965_Act_GG-40869_2017-05-26.pdf (accessed 31 January 2020).

Trade Map (n.d.). https://www.trademap.org/Index.aspx.

Vilakazi, T., and A. Paelo (2017). 'Understanding intra-regional transport. Competition in road transportation between Malawi, Mozambique, South Africa, Zambia and Zimbabwe'. WIDER Working Paper 2017/46. Helsinki: UNU-WIDER.

WEF (World Economic Forum) (2015). *Global Competitiveness Report 2014–2015*. Obtained from: https://www.weforum.org/reports/the-global-competitveness-report-2015 (nla).

World Bank (WB) (2014). *Country Review*. Prepared by the Malawi Office of the World Bank, Lilongwe, Malawi.

Young, E.M. (2005). 'Revival of industrial hemp'. Submission for Master's Degree in International Environmental Science, University of Lund, Sweden.

Appendix A: Abbreviations

ASWAp	Agriculture Sector Wide Approach (Malawi)
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries (SA)
DEA	Drug Enforcement Agency (US)
DoH	Department of Health
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FDA	Food and Drug Administration (US)
FISP	Farm Input Subsidy Programme
GAP	Good Agricultural Practices
GDFI	Gross Domestic Fixed Investment
GDP	Gross Domestic Product
GMP	Good Manufacturing Practice
IPS	Integrated Production System (Malawi)
OEMs	Original Equipment Manufacturers
R&D	Research and Development
SADC	Southern African Development Community
SAHPRA	South African Health Products Regulatory Authority
SIC	Standard Industrial Classification
THC	Tetrahydrocannabinol
USAID	United States Agency for International Development
WB	World Bank
WEF	World Economic Forum