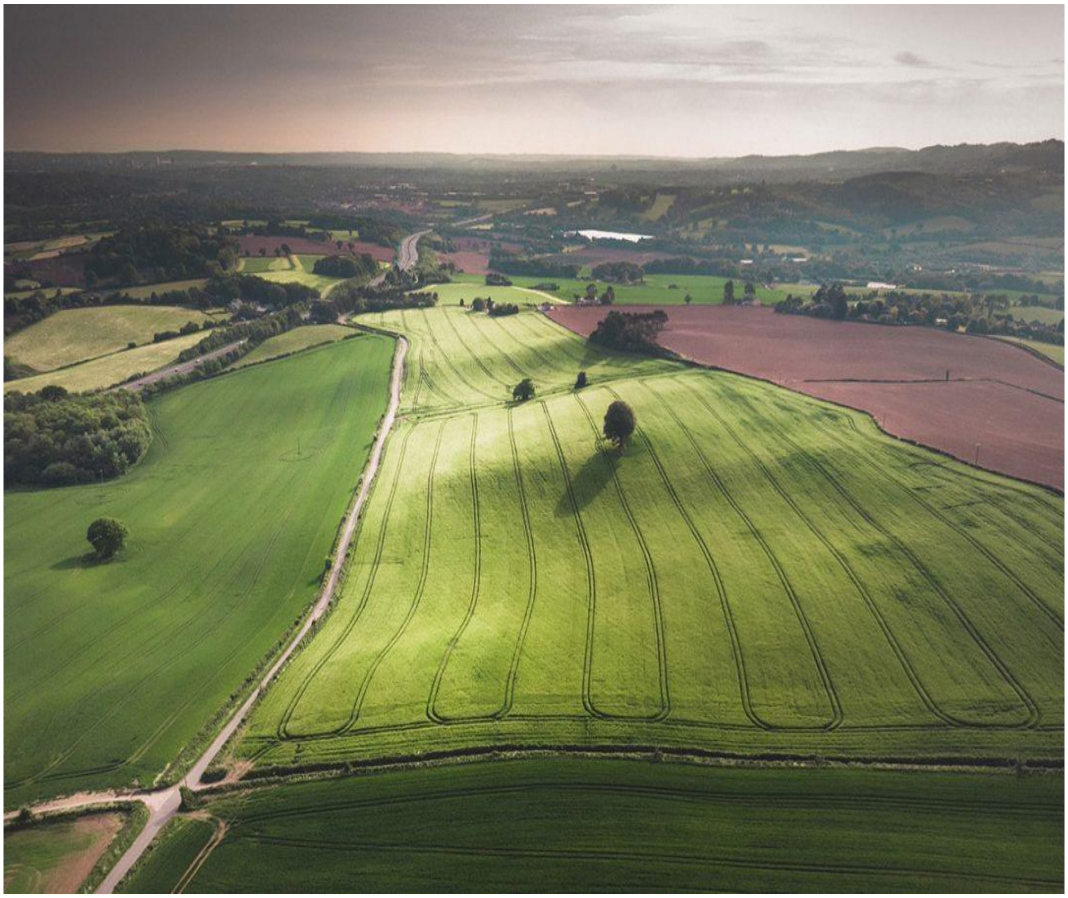
HCI’s Hemp Consultation Document



SEPTEMBER 30TH 2021

Hemp Cooperative Ireland (HCI)
Authored by: Board of HCI

Hemp Consultation Submission – Executive Summary

The objective of this submission is to propose that the Department of Agriculture fully explore the potential for growing fibre crops such as hemp, considering whether these crops have a viable market, to raise the profile of hemp farming in Ireland and to encourage the Department of Agriculture to fund further research and development on this magnificent crop and to engage in further conversation with the Hemp Cooperative of Ireland (HCI).

- Teagasc, led by John Finnan has done a lot of good research and trialing on hemp in the past and we feel their great work should be continued on and added to.
- We believe that there need to be as many incentives as possible to entice young people to become farmers and for this occupation to be a sustainable source of income. It's worrying that only 5% of farmers in Ireland are under 35.
- This report clearly shows that by increasing the amount of hemp grown in Ireland that we can alleviate many problems that the country faces right now.
- Hemp can be used as a nutritious plant protein in current times where experts say we need to decrease our meat intake.

Due to its late flowering (late July to Sept) which coincides with a scarcity of pollinator-friendly crop plants in Ireland, it can help our ever-decreasing bee population to survive and thrive as (these are one of our main pollinators so it's important to protect and promote them)

If hemp was covered under the GLAS scheme for wild bird cover it not only provides much-needed food for bees but would also be a good way for new growers to trial the crop for the first time.

It can improve the rumen function of our cattle, will create an extra avenue of income for Irish farmers along with promoting biodiversity and reducing our reliance on pesticides which are continuing to damage our wildlife, health, crops, soils, and rivers.

Increasing the amount of hemp grown here can help Ireland become a leader in carbon sequestration as it tackles to meet its 2030 commitments, this will be made all the easier with crops such as hemp as on average, it sequesters 10 tonnes of CO_2 per ha.

This submission will explain how an extra incentive like grants, could help to create an indigenous industry while also increasing the ever-growing interest in hemp farming.

It will also show how growing hemp in Ireland is financially viable based on a case study carried out in 2019 in which 10% of all hemp growers in Ireland participated (7 growers in total).

This shows that on average, hemp has a 39.5% higher gross margin return in comparison with its nearest cereal crop competitor which is winter wheat.

We believe that evidence is provided here to support all these points.

There are some interesting case studies that are included at the end along with all references from published papers.

HCI appreciates and thanks you for the time taken to read this submission and we hope you find it as interesting as we believe the industry to be.

We very much look forward to your response.

The HCI board

[redacted]

https://hempcooperativeireland.com/

About Hemp Cooperative Ireland (HCI)

Hemp Cooperative Ireland is a registered Cooperative with the aim of creating an infrastructure for farmers and regional businesses to develop the hemp industry in Ireland. Hemp Cooperative Ireland supports farmers to access resources, equipment, and markets through a national body and regional hubs.

Our Mission

The mission of the Hemp Cooperative of Ireland is to establish an infrastructure for the growth and development of the industrial hemp industry in Ireland at the regional and national levels.

Goals

- Educating the farming community and the public about the benefits of the industry.
- Developing a community of farmers and businesses to assist in the growth of all aspects of the industry.
- Liaising with local and national authorities to ensure that hemp farmers and business owners know and adhere to legislation and standards.
- Creating 100% Irish grown markets from seed to shop.

Hemp Cooperative of Ireland- Supported Research

Hemp is a multifaceted crop with the potential to increase revenue for Irish farmers while reducing Ireland's dependence on petroleum-based products. The Hemp Cooperative of Ireland is committed to improving the overall understanding of hemp's potential for positive environmental change in the agricultural sector.

To bring this high-quality, verified information to those that need it most, HCI has become involved with and initiated several research projects in various academic institutes across the country.

IT TRALEE: PRACTICAL PRODUCT DESIGN
PROJECT TITLE: DESIGN REQUIREMENTS OF A HEMP HARVESTER MACHINE TO EFFECTIVELY CUT AND SEPARATE THE STALK AND SEED OF THE HEMP CROP.

The Hemp Cooperative Ireland commissioned this practical study, which addresses new product design for hemp agriculture. The current upswing in hemp production differs from previous eras in that almost the entirety of the plant is now considered valuable.

The seeds, the stalks, the flowers and the overall biomass all have at least some commercial demand. Thus, separating the various components of the plant has become a real need for those who grow it.

Traditional hemp retting can take weeks. Even the most modern solutions take several days, so a method to reduce the time spent separating its different parts would be hugely valuable for promoting hemp's viability as a commercial crop for Irish farmers. Every hour saved counts.

This kind of practical, solution-focused research is crucial, as it fulfils a real-world need in the short term.

CREST: HCI COMMISSIONED PROJECT ON HEMP'S ENERGY POTENTIAL
PROJECT TITLE: ENERGY GENERATION AND CARBON SEQUESTRATION FROM INDUSTRIAL HEMP

The project was to investigate the potential of hemp to (1) produce ethanol as a transport fuel, (2) sequester carbon during its growth cycle, and (3) sequester carbon when used in the building product hempcrete over the building's lifecycle. The final stage was to attempt to monetise the above applications and extrapolate to industrial levels.

The innovation project involved the following agreed research and technical services:

1. Assess the ability of industrial hemp to generate energy and in particular the potential output of ethanol per acre/hectare of hemp grown.
2 Quantify the amount of carbon (kg carbon per tonne of hemp) that hemp can sequester during its growing cycle.
3 Quantify the amount of carbon a hempcrete house can sequester within its building fabric and over its whole lifecycle.
4 Apply monetary values to the above, where possible, and extrapolate the values to industrial scales.
5 Produce a report on the findings of the project

SHANNON ABC, LIMERICK IT, IT TRALEE
ONGOING COLLABORATION TO STANDARDIZE CANNABINOID EXTRACTIONS

Shannon ABC is an applied biotechnology centre created through a merger between the Natural Products Research Centre (NPRC) based at the Institute of Technology, Tralee and the Nutraceuticals Research Centre (NRC) at the Limerick Institute of Technology.

Their goal is to provide state-of-the-art research to commercial interests regarding natural products which contain bioactive substances of value.

The HCI is now collaborating with Shannon ABC and others to determine a clear set of standards for the extraction of cannabinoids in Ireland.

The number of products containing CBD destined for human consumption has increased exponentially in recent years. In many countries, legislation has struggled to keep pace with the rapid development of new products and formulations. Ireland is no exception to this.

The HCI believes that developing a coherent framework for certification and a clearly defined set of best practices, can protect the safety of Irish customers, and help establish Ireland's future as a model for the regulation of hemp across Europe.

It is hoped that the results of this study will provide a valuable basis for further regulatory progress about hemp in Ireland. Clearer data for any government or state body to draw on can only make for more effective policy.

The Hemp Cooperative is also involved in several other research projects, particularly its ongoing efforts to establish accreditation for hemp as a building material.

Definition and provisions

Hemp (Cannabis sativa Linn) is a species in the Cannabaceae family in which the level of tetrahydrocannabinol (THC) is very low, according to the provisions under the common agricultural policy (CAP). Hemp is grown primarily for its industrial uses and there are 75 different hemp varieties registered in the EU catalogue. Due to the very low level of THC, hemp complying with the provisions of the CAP is not used to produce narcotic drugs.

In accordance with Article 189 of EU Regulation 1308/2013, all imports of hemp are currently subject to an import licence requirement. In addition: raw true hemp falling within CN code 5302 10 must have a THC content not exceeding 0.2%;
hemp seeds for sowing must be accompanied by proof that the THC content of the variety concerned does not exceed 0.2%;

hemp seeds not used for sowing may be imported only under the authorisation of the EU countries, and authorised importers must submit proof that the seeds have been placed in a condition that excludes use for sowing.
EU countries may also apply more restrictive rules in line with EU treaties and international obligations.

Support available under the CAP

Farmers who grow hemp are eligible for area-based direct payments under the CAP. Farmers must meet the standard eligibility conditions for direct payments, as well as additional requirements specific to hemp ensuring that no illicit crops receive any CAP support.

The variety of hemp being cultivated must have a THC content below 0.2%.
Farmers must use certified seed of varieties listed in the EU common catalogue of varieties of agricultural plant species. There are 75 different hemp varieties registered in this catalogue.
EU countries can decide to grant, under certain conditions, voluntary coupled support (VCS) to farmers growing hemp. VCS for hemp is currently implemented in France, Poland, and Romania.

Hemp farmers may also benefit from support implemented through rural development measures available under the second pillar of the CAP. Relevant types of support are designed to facilitate investments, knowledge-building, business start-ups, innovation, supply chain organisation, organic farming, environmental protection, and climate action.

Source: https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/hemp_en#supportavailableunderthecap

Constituents of Hemp

Hemp stalk

WHOLE STALK		HEMP SEED		
Bast Fibre	**Woody Core (Hurd)**	**Hemp Nut**	**Hemp Oil**	**Seed cake**
Textiles - Clothing - Bags - Shoes - Socks	**Building products** - Fibreboard - Insulation - Hempcrete	**Foods** - Bread - Granola - Icecream - Milk	**Foods** - Salad Oil - EFA Food Supplement - Margarine	*(after pressing)* - Animal feed - Protein rich flour
Technical textiles - Cordage - Netting - Canvas - Carpeting	**Industrial products** - Animal bedding - Boiler fuel - Mulch - Chemical absorbant	- Cereal - Protein powder	**Bodycare** - Soap - Shampoo - Hand Cream - Cosmetics - Lip Balm	
New products - Geotextiles - Biocomposites - Nonwovens - Pultrusions - Compression Moulding	**Paper** - Printing - Filters - Packaging - Newsprint - Cardboard	**Whole stalk uses** - Biofuels - Ethanol - Erosion control blankets	**Technical products** - Oil paints - Solvents - Varnish - Lubricants - Printing Ink - Diesel Fuel - Coating	

Figure 1 Uses for hemp

As shown in Figure 2 below, the stalk is made up of the outer skin called the vascular cambium, the bast fibre and the woody inner core, which is known as the shiv (O'Connor, 2007). Hemp can be specifically grown for high-quality fibre. However, it needs to be harvested when the plant has finished flowering and before the seed has a chance to reach maturity, otherwise the fibre is of a lower quality (Cochran, et al., 2000) (Salentijn, Petit and Trindade, 2019). The stalks contain cellulose, pectin, and other cellular tissues (O'Connor, 2007).

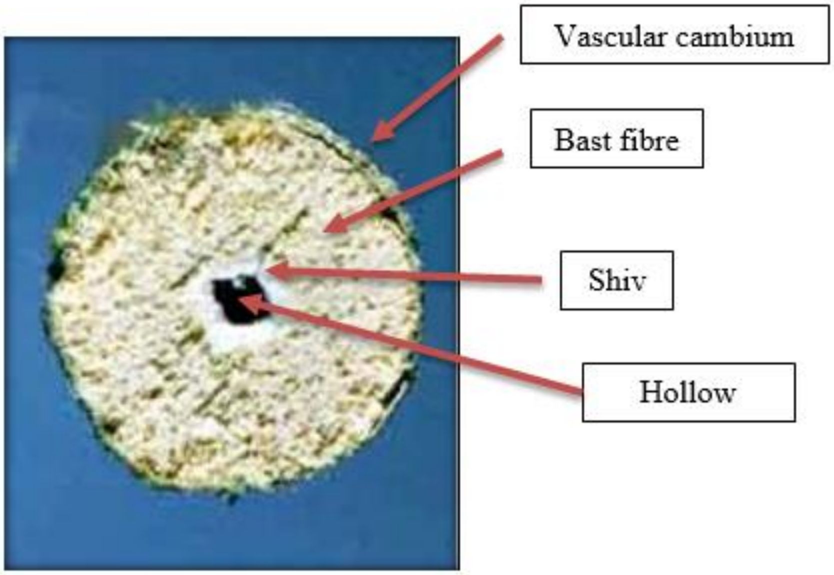


Figure 2 Cross-sectional area of the hemp stalk

Adapted from (O'Connor, 2007)

Retting

After cutting, the stalk needs to remain in the field for several days to undergo a process called retting. Retting decomposes or dissolves the pectin and the cellular tissues that surround the bast-fibre bundles. This makes it easier to separate the fibre from the stems later on (Zahoor et al., 2015) (Liu et al., 2015). After being cut the stalks will rapidly lose moisture. Depending on the weather conditions, the stalk can decrease from 65% to 35% in the first week and eventually reach a low of 16% after 3 weeks (Finnan and Burke, 2013b). The stalks should be turned once or twice to allow even retting to take place, otherwise, the stalks on the ground will stay green and the ones on top will go brown. When the fibres turn grey or gold in colour and are easy to separate from the wood into fine fibres, then retting is complete.

However, cellulose is not broken down easily and therefore by undergoing a mechanical process it is easier to obtain relatively clean fibre bundles (O'Connor, 2007). Once turning with hay rakes and retting is complete, the crop can be harvested with a large round or square baler (Cochran, Windham and Moore, 2000). The straw can then be sent for a process called decortication and fibre separation as outlined in Figure 1.12, or if there is no access to a decorticator it can be used as animal bedding (Hobson and Carus, 2008).

Figure 3 Decortication process

Source: (Hobson and Carus, 2008)

Hemp fibre

The outer stem which is known as the bast fibre is used for manufacturing clothes, canvas, and ropes. The fact that hemp is naturally antimicrobial and anti-mildew makes it ideal for these products. Hemp manufactured clothes are comfortable and cool to wear and touch (O'Connor, 2007). These fibres can be used to produce 100% hemp products but can also be combined with other fibres, such as cotton or silk, for apparel and furnishings (Crawford, Deards and Moir, 2012). The male plant produces finer fibre which is an advantage for use in the textile industry (Salentijn et al., 2019). Before the rediscovery of industrial hemp in the 1990s, nearly all the hemp fibre produced was used for speciality pulp and paper. The hemp pulp was mainly used in items like cigarettes, Bible paper and banknotes as it was nearly 5 times more expensive than wood pulp and paper.

A great deal of research and development was undertaken during the 1990s by the European Commission (EC) and their member states to uncover new applications for hemp fibres. In 2013, as outlined in Figure 1.13, 57% of hemp produced was made into pulp and paper, making it still the largest market for hemp fibre. Hemp paper is a high-quality product, and it is also very strong. Furthermore, it requires no bleaching due to its low lignin content and its manufacture produces no dioxins. In fact, an acre of hemp produces over 4 times more pulp for papermaking than an acre of trees if taken over a yearly output. This can ease some of the unsustainable land burden taken up by forests (O'Connor, 2007). Hemp has some of the best mechanical properties in the world compared with all the other natural fibres (Carus, 2017). As outlined in Figure 1.13, other products included insulation for the construction industry (26% of all hemp fibres) and biocomposites for the automotive industry (14% of all hemp fibres).

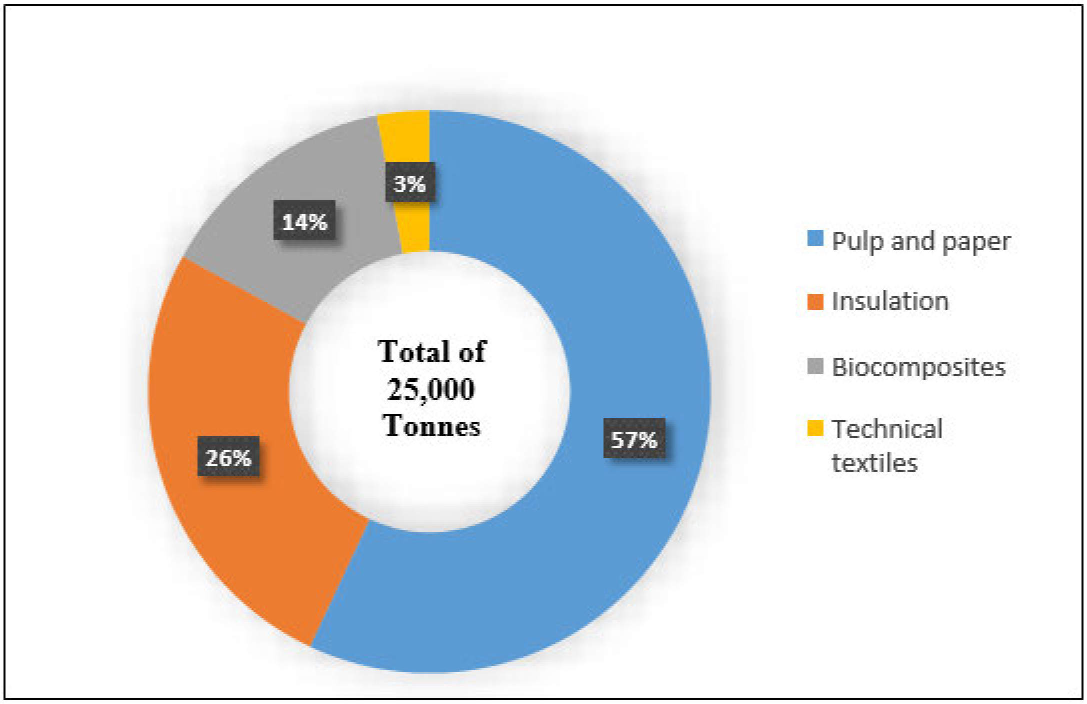


Figure 4 Applications for European Hemp Fibre from the 2013 harvest.

Source: Adapted from (nova/EIHA 2016) (Carus, 2017)

Expected yield

Yield is a very important factor when testing the feasibility of any crop but there are a lot of variables involved like, seed type, soil type, moisture levels throughout the year, time of sowing and harvesting along with many others. The reported figures from different countries have a wide range but the average appears to be about 5 tonnes per acre under good conditions (Cochran et al., 2000). Yields as high as 10-14 t/ha can be produced by sowing hemp in early to mid-April to ensure maximum yields (Crowley, 2001). The longer the crop was left before cutting meant the yields increased from 11.1 to 12.2 tonnes of dry matter per hectare. The highest yields were obtained from the variety with the latest maturation date (Finnan and Burke, 2013b).

Dual-purpose varieties of hemp were reported to have yields of 5 tonnes per hectare for the fibre portion and 1.25 tonnes per hectare of seed. Typical values for the fibre were given as €184.50 per tonne and €626 per tonne for seed in a report carried out by the environmental consulting company ADAS over a decade ago. This means that dual crops have a 23% higher return over traditional fibre varieties and is confirmed by a report carried out in 2008 for Enterprise Ireland

(Zahoor et al., 2015). As mentioned previously, hemp seed production has increased by 92% from 2010 to 2013 as demand has increased and in turn, the price has increased (Carus, 2017). In fact, experts in Ireland now say that hemp seeds are worth €1500 per tonne now due to the recent increase in demand.

Cutting and harvesting

Depending on the primary end-use, the growing season for hemp is normally between 120-150 days which would normally mean harvesting would take place in August through September (Crowley, 2001) (O'Connor, 2007). For fibre production, the crop is usually cut, retted in the field baled and stored or processed. Harvesting stalks for high-quality fibre occurs as soon as the last pollen is shed with the machine set to its maximum height. Harvesting for seed occurs four to six weeks later when 60% of the seed has ripened. (O'Connor, 2007).

Tiered mowing systems such as finger bar mowers offer a superior method for mowing hemp, as it enhances the crops drying rates and in turn, it makes the baling operation less problematic. Conditional mowers and drum mowers are unsuitable for cutting as the hemp stalk will eventually wrap around the rotating parts. Once mowed, hay rakes such as a swather rake can be used to rake the hemp into windrows. This type of machine works successfully as it has a cam-type action and not a rotation type. Round balers are better than square balers when it comes to whole stalks but as mentioned earlier, it's better if the crop is cut into sections. Variable chamber balers or belt balers are recommended over roller balers (Finnan and Burke, 2013).

After retting has occurred, the stalk can then be baled and processed if a decorticator is available. Otherwise, it can be stored and used as bedding for animals. Harvesting requires cutting the stems at the ground level. Harvesting is more efficient when special equipment is used. However, it is also possible to harvest hemp using conventional equipment that is used for harvesting forage crops. After harvest and field drying, the hemp stalks can be collected with a baler. John Deer in Holland is one example of a company that has produced a piece of equipment called the John Deere Kemper harvester that can cut and chop hemp stalks (O'Connor, 2007).

According to experts, when harvesting for seed or flower, a stripper head can be used or combine with a trailer attachment to separate the seed and flower, via a chute, while also cutting the stalk. A lot of smaller hemp farmers handpick their crop but it can be very labour intensive, so it is recommended to keep the number of acres to a minimum.

If harvesting for flower and leaf, the crop should be grown to peak CBD values and then the harvester cuts the flower portion of the crop which will be collected in a hopper. Sometimes this process can damage the trichomes on the flower as the equipment is rotating at high speed. This may result in potential CBD losses. The flowers will then need to be dried before the extraction process can take place. The drying process is extremely important as high heat can also result in potential CBD losses (Christensen, 2019).

Hemp shivs

Hemp shivs are the inner, woody core of the stalk that can be extracted by decortication, as previously described in Figure 1.12. In addition to hemp fibres, decortication also produces hemp shivs which is the inner stem and can be used for more coarse-fibre products, including animal bedding (Crawford et al., 2012). There will be 1.7kg of shivs produced for every 1kg of fibre. It's quite important to produce them as cleanly as possible to add extra value to the crop if selling them on, or as a high-quality product if going to be used as animal bedding.

Because the shivs can hold up to 4 times their dry matter weight, it is considered a high-performance bedding material that will need less changing than traditional bedding materials such as straw and therefore will save on labour costs. It can also be used as an excellent compost material once discarded (Carus, 2017).

As outlined in Figure 1.14, figures from the 2013 hemp shivs harvest show that 45% of shivs produced were used as horse bedding. Coolmore Stud is currently importing hemp bedding for their horses in Ireland according to the Department of Agriculture. 18% of hemp shivs were used on other animal bedding and 16% were used for construction purposes after being mixed with lime which is an ever-increasing market (Carus, 2017) (Musio et al., 2018).

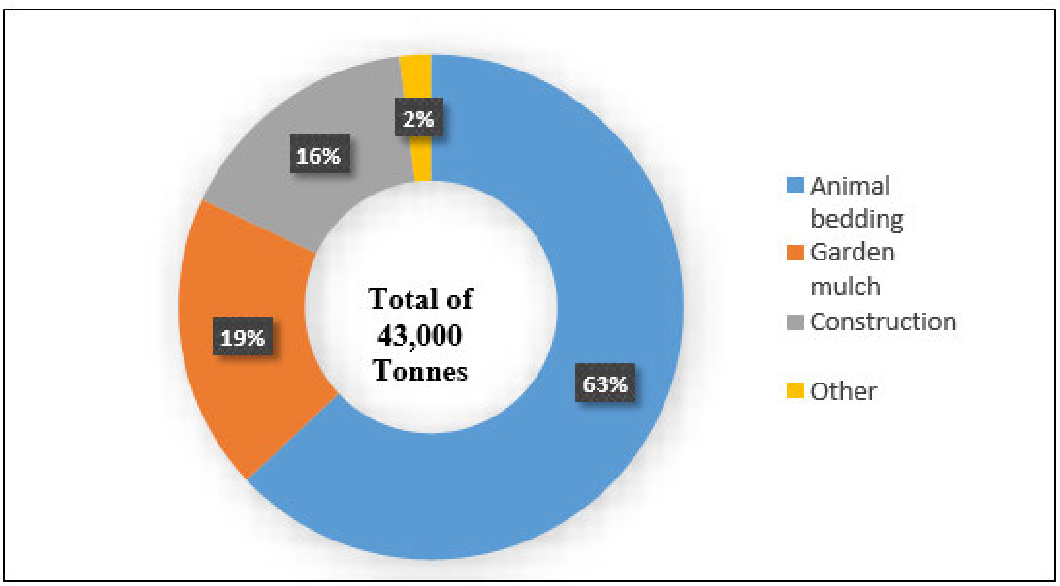


Figure 5 Applications for European Hemp Shivs from the 2013 harvest.

Adapted from (nova/EIHA 2016) (Carus, 2017)

Table 1 provides a summary of the agronomic issues encountered by the participants in this study. These are categorised into processing, climate, cultivation and harvesting issues.

Table 1 Agronomic issues encountered for hemp growers.

Issues	Description
Climate	Weather can be an issue like every crop, drought, frost, excess rain.
Cultivation	Sowing at a low seed rate can give the weeds a better chance to grow with the crop especially if growing organically as no pesticides.
	Issues with birds eating the seeds after sowing.
Harvesting	Can be labour intensive if harvesting by hand.
	Issues with rotating parts in machines. There is a need for specialised equipment to be developed to make the harvesting operation run smoothly.
Processing	Better drying solutions needed.

Table 2 Participant's roadblocks

Roadblocks	Recommendations
Licencing	Regulations need to be eased to allow different varieties with higher CBD content.
	Licence needs to be updated and relaxed.
Processing	Need to have a decorticator so the fibre can be processed to add more value.
	More machines on the market for harvesting.
	Lack of finance and processing units.
Government	Laws need to be looked at to allow varieties with a higher THC content to be sown.
	Have some support for hemp from the government.
	Education in hemp growing and hemp uses for the government bodies and the public.

Table 2 shows the summary of the participants' roadblocks that need to be removed to help make hemp growing in Ireland more viable and their suggested changes and recommendations.

Figure 6 shows the summary of the optimum number of acres that a farmer should sow according to the participants surveyed.

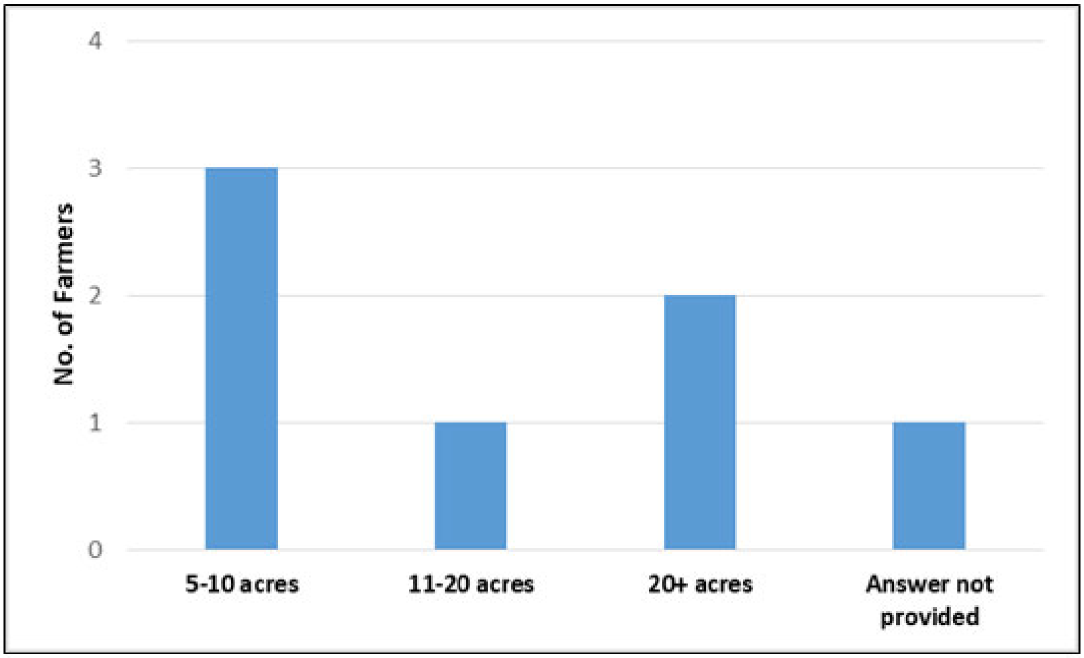


Figure 6 Optimum number of acres to sow when growing hemp.

Figure 7 shows the summary of the best advice for somebody interested in growing hemp for the first time in Ireland.

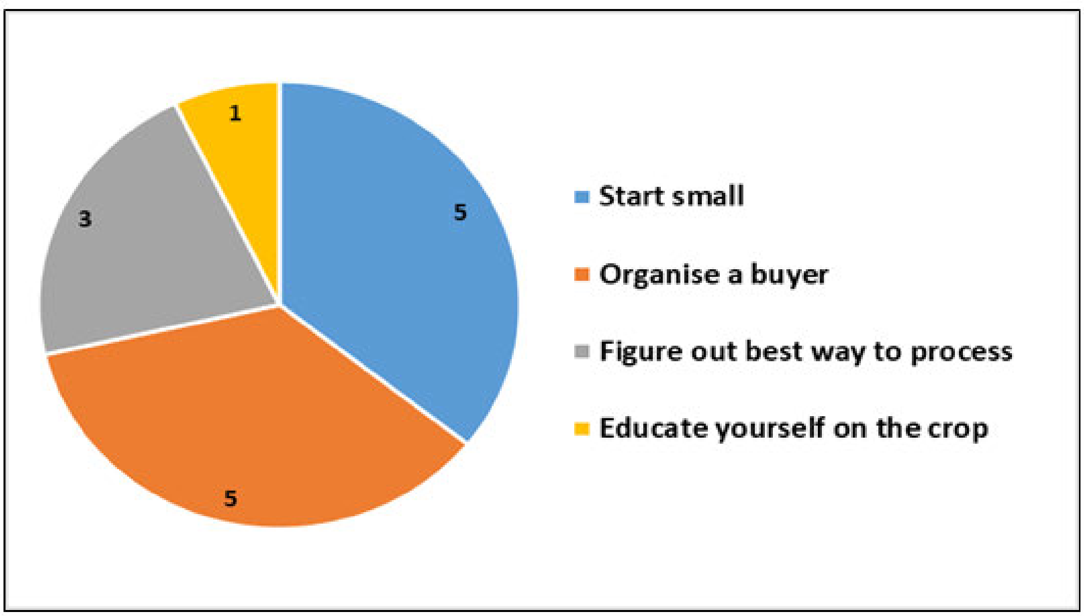


Figure 7 Participant's advice for new hemp growers in Ireland.

In Table 3, a comparison is made between the variable costs (€/ac) associated with growing hemp organically and the 3 main cereal crops in Ireland.

Table 3 Cereal crop variable costs 2019 compared with hemp €/ac.

2019 CEREAL CROP MARGINS
Variable Costs excl. VAT (€/ac)

	Feed Wheat		Feed Barley		Feed oats		Organic Hemp
	Winter	Spring	Winter	Spring	Winter	Spring	
Materials	328	263	296	229	237	212	150
Seed	34	40	38	40	37	39	150
Fertilisers	178	147	155	132	137	120	0
Sprays:							
Herbicides	23	18	23	18	12	12	0
Fungicides	78	51	55	37	42	32	0
Insecticides	9	2	13	2	2	2	0
Growth regulators	6	4	12	0	6	6	0
Hire Machinery	182	174	174	159	167	167	135
Plough, One-pass & Roll	72	72	72	72	72	72	72
Spray	41	33	33	24	33	33	0
Fertiliser Spreading	21	21	21	14	14	14	14 *
Harvesting	49	49	49	49	49	49	49
Miscellaneous	40	29	37	25	32	24	32
Interest (6%)	13	7	12	6	10	6	10
Transport (€6/Tonne)	27	22	24	19	22	18	22
Total Variable Costs	550	466	507	413	436	403	317
Price (€/Tonne)	170	170	160	160	155	155	1500
Straw (€/ac)	98	80	121	101	100	87	120
Break even yield (grain only)	3.2	2.7	3.2	2.6	2.8	2.6	0.2
Cost per tonne @ target yields**	125	129	127	129	121	134	594

Adapted from Teagasc Crops Costs and Returns 2019 (Collins and Phelan, 2019)

* €14/ac accounts for slurry spreading as no fertiliser is used if growing organically.

** Crop target yields are set by Teagasc each year for all crops.

Table 4 outlines the gross margins (€/ac) of hemp and the 3 main cereal crops grown in Ireland in 2019. Figures for hemp are calculated using feedback from participants and experts on hemp growing with expected yields.

Table 4 Cereal crop gross margins comparison €/ac.

GROSS MARGINS (€/ac) (Incl. Straw)							
	Feed Wheat		Feed Barley		Feed oats		Hemp
t/ac	Winter	Spring	Winter	Spring	Winter	Spring	
0.5	-367	-300	-305	-218	-258	-238	**<u>413</u>**
2.6	-10	57	31	104	67	88	
3.0	58	125	95	168	129	**<u>150</u>**	
3.2	92	159	127	**<u>200</u>**	160	181	
3.6	160	**<u>227</u>**	191	264	**<u>222</u>**	243	
4.0	228	295	**<u>255</u>**	328	284		
4.4	**<u>296</u>**		319				
4.9	381						

Adapted from Teagasc Crops Costs and Returns 2019 (Collins and Phelan, 2019)

*Crop target yields are set by Teagasc each year for all crops and underlined and in bold.

In Table 5, a comparison is made between the variable costs (€/ha) associated with growing hemp organically and the 3 main cereal crops in Ireland, as discussed in Table 3 previously. Figures for hemp are calculated using feedback from participants and experts on hemp growing.

Table 5 Cereal crop variable costs 2019 compared with hemp €/ha.

2019 CEREAL CROP MARGINS Variable Costs excl. VAT (€/ha)	Feed Wheat		Feed Barley		Feed oats		Hemp
	Winter	Spring	Winter	Spring	Winter	Spring	
Materials	810	650	731	566	585	524	371
Seed	84	99	94	99	91	96	371
Fertilisers	440	363	383	326	338	296	0
Sprays:							
Herbicides	57	44	57	44	30	30	0
Fungicides	193	126	136	91	104	79	0
Insecticides	22	5	32	5	5	5	0
Growth regulators	15	10	30	0	15	15	0
							0
Hire Machinery	450	430	430	393	412	412	333
Plough, One-pass & Roll	178	178	178	178	178	178	178
Spray	101	82	82	59	82	82	0
Fertiliser Spreading	52	52	52	35	35	35	35*
Harvesting	121	121	121	121	121	121	121
Miscellaneous	99	72	91	62	79	59	79
Interest (6%)	32	17	30	15	25	15	25
Transport (€6/Tonne)	67	54	59	47	54	44	54
							0
Total Variable Costs	1359	1151	1252	1020	1077	995	758
Price (€/Tonne)	170	170	160	160	155	155	1500
Straw (€/ha)	242	198	299	249	247	215	296
Break even yield (grain only)	8.0	6.8	7.8	6.4	6.9	6.4	0.5
Cost per tonne @ target yields*	125	129	127	129	121	134	594

* €35/ha accounts for slurry spreading as no fertiliser is used if growing organically.

** Crop target yields are set by Teagasc each year for all crops.

Table 6 outlines the gross margins of the 3 main cereal crops grown in Ireland in 2019 as per the Department of Agriculture and Teagasc in comparison with organic hemp growing. These figures are given in €/ha as outlined in Table 3 previously. Figures for hemp are calculated using feedback from participants and experts on hemp growing.

Table 6 Cereal crop gross margins comparison (€/ha).

GROSS MARGINS (€/ha) (Incl. Straw)							
	Feed Wheat		Feed Barley		Feed oats		Hemp
t/ha	Winter	Spring	Winter	Spring	Winter	Spring	
1.2	-906	-741	-753	-538	-637	-588	**<u>1020</u>**
6.5	-12	153	89	269	178	229	
7.5	158	323	249	429	333	**<u>384</u>**	
8	243	408	329	**<u>509</u>**	411	461	
9	413	**<u>578</u>**	489	669	**<u>566</u>**	616	
10	583	748	**<u>649</u>**	829	721		
11	**<u>753</u>**		809				
12	923		969				

Adapted from Teagasc Crops Costs and Returns 2019 (Collins and Phelan, 2019)

*Crop target yields are set by Teagasc each year for all crops and underlined and in bold.

Introduction to Hemp and the EU/ Global Markets

Hemp production in the EU

Hemp is a crop grown across Europe. In recent years the area dedicated to hemp cultivation has increased significantly in the EU from **19,970 hectares (ha) in 2015 to 34,960 ha in 2019 (a 75% increase)**. In the same period, the production of hemp increased from **94,120 tonnes to 152,820 tonnes (a 62.4% increase)**. France is the largest producer, accounting for more than 70% of EU production, followed by the Netherlands (10%) and Austria (4%).

https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/hemp_en#supportavailableunderthecap

In 2016, European countries produced hemp on 82,250 acres (33,300 hectares) according to the European Industrial Hemp Association (EIHA), a consortium of the hemp-processing industry, (EIHA, 2017a). This was a record high, which accounted for about 40% of Food and Agriculture (FAO) of the United Nations reported global acreage (Congressional Research Service, 2018), which notably does not include data for Canada. In 2017. Further evidence that there was a growing trend in hemp in the EU came in 2017 when an estimated 42,500 hectares were under cultivation, as shown in Figure 1.

Figure 8 shows a breakdown of the area of hemp in the EU from 1993 to 2017, with France being the major producer throughout this period. Hemp cultivation in the EU has been growing steadily since 2012.

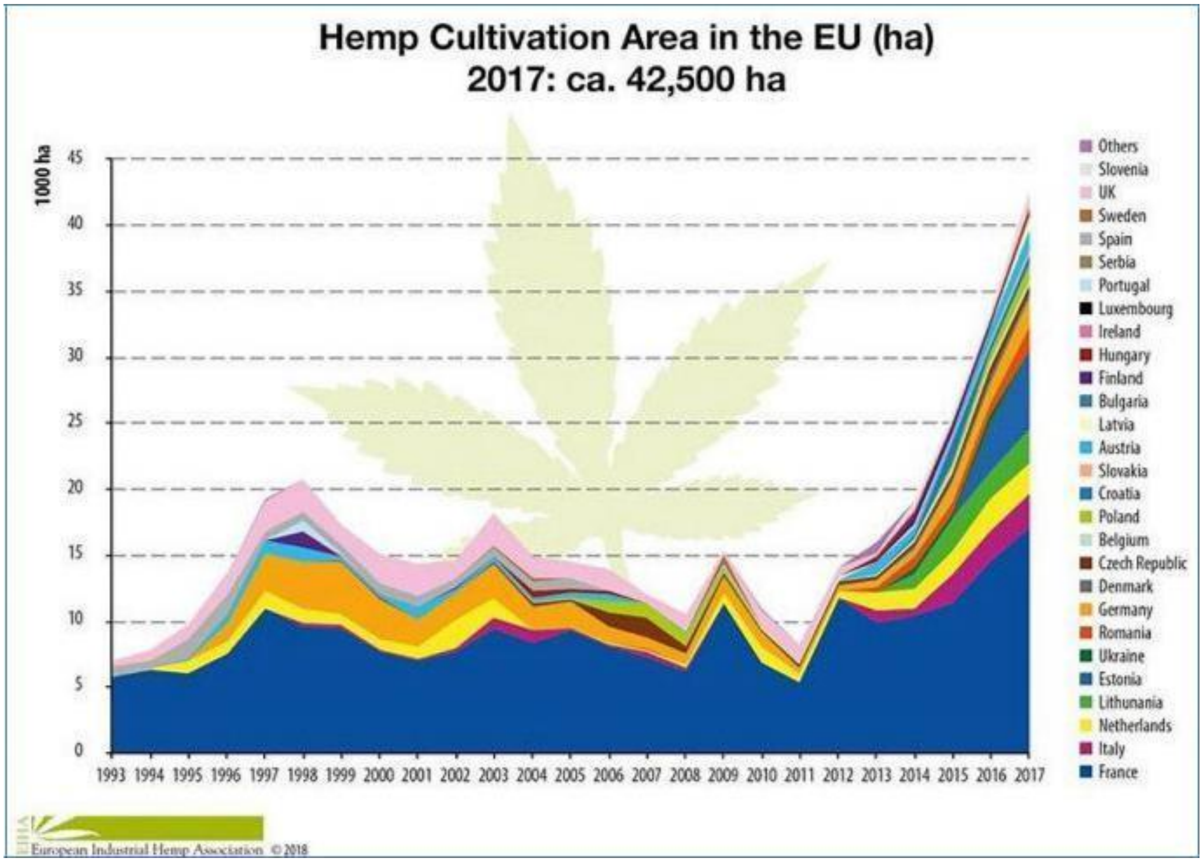


Figure 8 Source: EIHA. European Union hemp cultivation area 1993 to 2017

The EHIA (EHIA, 2017a) reported that the 15,700 hectares cultivated in 2013 (year of the last big survey), yielded 85,000 tonnes of hemp straw which was harvested and processed 25,000 metric tonnes fibre and 43,000 metric tonnes shivs (the woody core of the stem)

The relation between shivs and fibres (shivs: fibres) is 1.7 to 1. 13,000 metric tonnes of dust (60% pelletized for incineration, 40% for compost and other uses).

Figure 9 shows a breakdown of hemp fibre applications from the EU harvest in 2013.

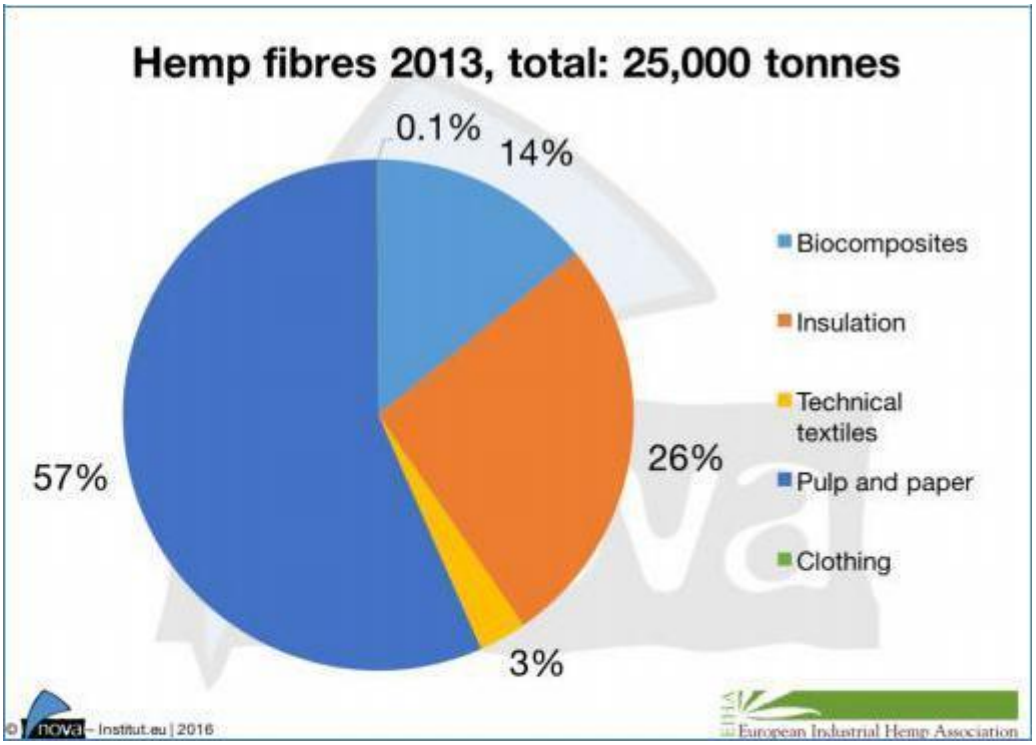


Figure 9 Hemp fibre applications from 2013 EU harvest

In Europe, hemp is predominantly used for fibre production (e.g. in the paper and automotive industries). However, hemp has only a small share of the total use of natural fibres. Hemp pulp and paper is still the most important market for European hemp fibres with a share of 57%, supplied mainly by French producers with insulation materials and biocomposites accounting for 26% and 14% of the applications, respectively (EHIA, 2017a). In early 2017, the price range for hemp fibres started from about 50 Eurocent/kg for the cigarette paper industry (ca. 25% shiv content) to around 75 Eurocent/kg for automotive and insulation (2-3% shiv content) (EHIA, 2017a).

Figure 10 shows a breakdown of hemp shiv applications from the EU harvest in 2013.

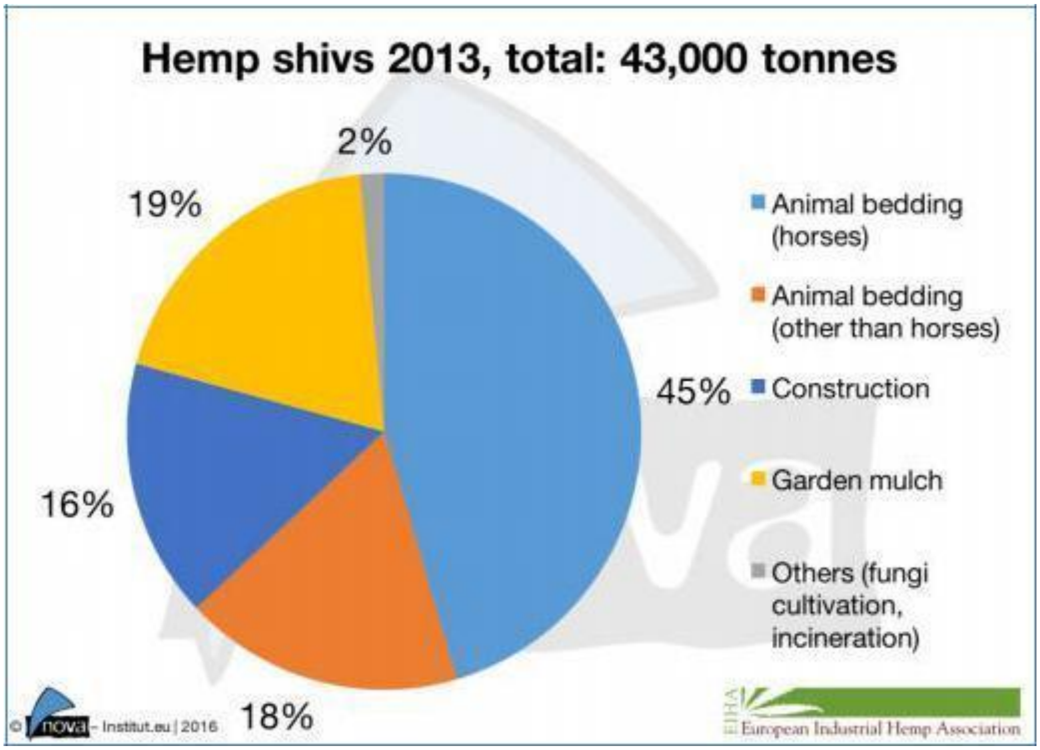


Figure 10 Hemp shiv applications from 2013 EU harvest

Horse bedding is the predominant hemp shiv application, with a market share of 45%. Other animal bedding was 18%, giving a total of 63% of the total hemp shiv applications in 2013. Since the 2010 hemp survey, interesting new use of hemp shivs is in combination with lime for construction (hempcrete), where the market share for shivs rose to 16% in 2013 (EHIA, 2017a).

Global hemp production

Approximately thirty countries throughout Asia, Europe, South America, and North America permit hemp production (Congressional Research Service, 2018).

In China, historically the mother country of industrial hemp, hemp is being reintroduced, especially for the textile industry and the total area has increased from 40,000 ha in 2016 to 47,000 ha in 2017 (EIHA, 2018). Canada's hemp area increased from 34,000 hectares (ha) in 2016 to the new record high of 56,000 ha in 2017 (EIHA, 2018).

Hemp production is now allowed in the United States (US) in accordance with the requirements under the 2014 Farm Bill provision, but aspects of production are still subject to Drug

Enforcement Agency (DEA) oversight, including the importation of viable seeds, which requires DEA registration according to the Controlled Substances Import and Export Act. Nineteen states grew hemp in 2017 and totalled 23,343 acres (9,450 ha) (Agweb, 2017). The area of hemp is expected to grow in the US by 50,000 ha in the next ten years (EIHA, 2018).

● The current markets that exist for fibre from hemp

a. Insulation.

There are no large-scale indigenous fibre producing groups or companies in Ireland, however, one of the key hemp-related markets that are developing in Ireland relates to the use of hemp insulation.

The use of natural insulation has become increasingly popular with architects and specifiers looking for alternative solutions for new builds due to not only the growing concern for the environment, but they need to ensure improved levels of health and comfort alongside the need to improve energy efficiency within new and existing buildings.
Hemp Insulation materials can offer significant advantages compared to the familiar traditional insulation material if they are used in the right way

Some existing Irish companies that use Hemp insulation are:
Ecological building systems.
Hempire – Clones Co. Monagahan. Sells and produces hemp building materials
Hempbuild – Kells, Co. Meath – Distributor of hemp building materials
Skyscraper – Co. Kerry Retailer of hemp products

Application of Hemp Insulation

Hemp insulation products are suitable for thermal and acoustic insulation of roofs, facades and floors in new and existing constructions. This material is the natural alternative to synthetic and mineral insulation materials. Besides traditional construction techniques, hemp insulation is ideal for timber frame constructions. When hemp insulation materials are used in 'vapour-permeable building constructions, the unique qualities of this natural product become even more enhanced.

Hemp insulation in use in Ireland.

One example of high-end natural insulation material on the market is Hempflax Plus. Hemplflax is a high-quality insulation material made from the fibre of the industrial hemp plant. A natural (and sustainable) product with exceptional insulating properties

Hempflax has gone through European standards testing and outlines the insulation qualities that can be achieved using hemp insulation, which is documented in table 7 below:

Table 7 EU standards testing for hemp insulation.

FEATURES

European admission		ETA-13/0518
Composition HempFlax Plus		90% hemp fibre, 10% bico fibre
Density		35,5 (kg/m^3)
Thermal conductibility (A)		0.040 W/mK
Fire class		Euroclass D-s1, d0
Flame retardant (< 1%)		Ammonium salt
Thermal storage capacity (c)		1800 (J/kgK)
Sound absorption factor (aw)		0/95 (at 14 cm thickness)
Vapour diffusion resistance factor (μ)		< 1.5
Air flow resistance		≥ 2.0 (kPa.s/m^2)
Mould formation		class 0, no mould formation established
Dimensional tolerance:	• length • width • thickness	± 2% ± 1,5% ± 5% of 5 mm max
Energy input (m^3 material)		50 - 80 (kWh/m^3)

Heat protection offered by Hemp insulation rivals that of conventional, carbon-based insulation. Figure 11 below demonstrates the heat protection qualities produced by hemp insulation.

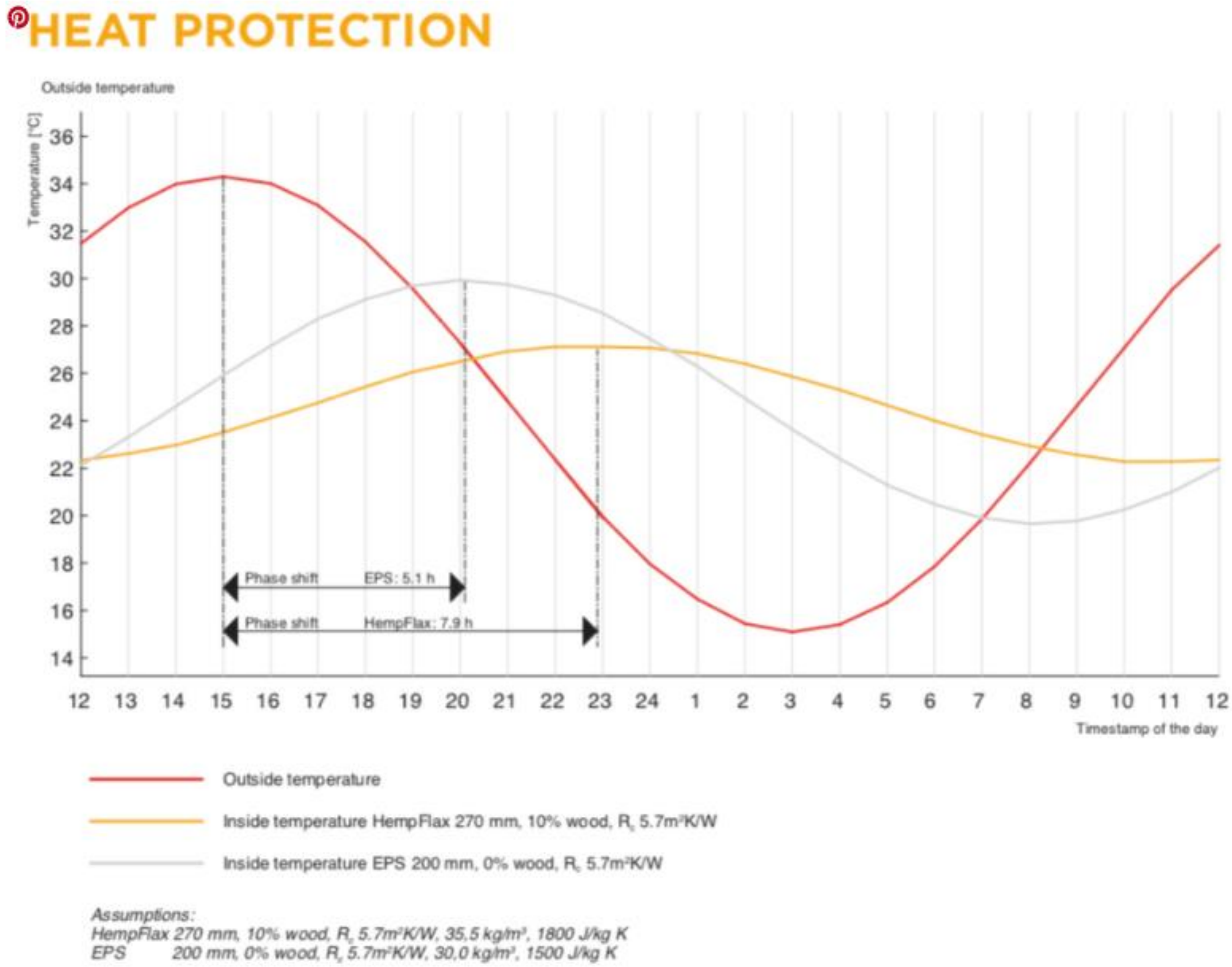


Figure 11 Heat protection qualities produced by hemp insulation

Natural insulation materials offer genuine performance advantages over nonrenewable alternatives such as stone wool, glass wool and polymer foam. For instance, the thermal conductivity of mineral-based material is severely compromised by moisture whilst natural material continues to provide effective insulation even after absorption of up to 30% of its own weight in water. In fact, this ability to absorb and desorb water vapour prevents the accumulation of moisture at sites where it may cause damage.

Renewable products can also store around twice as much heat as mineral alternatives for an equivalent thickness and density offering thermal buffering against swings in the external temperature. In addition, the flexibility of natural fibres makes them effective acoustic insulation agents.

In terms of their ecological profile, hemp insulation has lower embodied energy. They are also safer for operatives to handle than mineral products and, finally, they can be composted or burnt for energy recovery at end of life.

All crop-based insulation materials are imported, However, the development of domestic markets through procurement policies or fiscal support for ecologically desirable products could change this. For instance, in Germany, renewable insulation materials attract government support of 40 cents per cubic metre

High investment costs for machinery to process hemp fibre.

Hemp insulation is the most obviously identifiable market for hemp fibre crops, however large machinery called a decorticator is required to process the stalks of the hemp plant into fibre and shiv.

The ability to process hemp stalk in Ireland is very limited at present due to the investment required to purchase a decorticator. The cost of a decorticator starts at around EUR500,000.

The HCI had commenced initial discussions in early 2021 with the Leader programme to explore the possibility of facilitating the purchase of a decorticator. However, the HCI was subsequently advised that it would not be possible to allocate funding towards such a project, the reason given was that they don't fund hemp projects.

This demonstrates the requirement for better recognition of industrial hemp and buy-in from government bodies to assist with the development of the Irish hemp industry.

The raw material produced from a decorticator, fibre, shiv and dust, can be processed into hundreds of other by-products, however, hemp insulation is the most viable fibre product identified by the HCI.

b. Textiles

Textile manufacture in Ireland is limited, due to the lack of fibre processing equipment (carding, combing, and spinning). The industry surrounding wool processing has long since moved to Asia due to the lower costs of production, environmental regulation tightening (discharges/ chemical use) and general overall labour costs.

Hemp could play a part in a resurgence of an indigenous textile industry, given the durability, reduced water use and availability of fibre, but requires investment to develop modern facilities capable of decortication, fibre cleaning, spinning and finally weaving.

Non-woven's, such as wadding for mattresses and sofas, duvet fillings and other horticultural uses like natural weed suppression and as a support for seedling growth.

Hemp fibre is very similar to linen and the interest of the textile industry in using hemp fibre is growing. The European Commission, in its circular economy action plan, considers the textile sector as one of the cornerstones in the transition towards a greener and more sustainable economy and it has encouraged stakeholders to seek new materials and new economic models. To this end, the Commission will propose a comprehensive EU strategy for sustainable textiles aiming to create a more sustainable, innovative, circular economic model.

https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/hemp_en#supportavailableunderthecap

Hemp fiber is a high natural performance bio-based fiber
*Wet spinning of pure hemp yarn 10.5NM----90NM for weaving & knitting
*Hemp blended yarn with: organic cotton recycle polyester Tencel, modal, rayon wool, yak
The gum in hemp bast fiber is much higher than that of ramie and flax, which increases the technical difficulty of processing hemp fiber

Table 8 Various fibre biopolymer constituents

Name	Cellulose %	Hemicellulose %	Pectin %	Lignin %	Fat wax %	Water soluble %	Ash %
Apocynum	40.82	15.46	13.28	12.14	1.08	17.22	3.82
Ramie	65-75	12-16	3-6	0.8-2	0.2-1	6-8	2.5-4.5
Flax	60-70	15-18	2-3	6-8	2-3	4-5	0.2-1
Hemp	54.47	18.46	6.84	6.38	1.02	12.83	4.61

c. Building materials (hempcrete and hemp board)

Carbon sequestration in hemp-lime construction

Buildings are responsible for a large proportion of total global emissions. According to Innovate UK (2015), the construction, operation, and maintenance of the built environment account for 37% of total UK greenhouse gas emissions. Inhabitat, (2019) reported that according to the U.S. Green Building Council, buildings account for thirty-eight per cent (38%) of the CO_2 emissions in the United States of America and demand for carbon neutral and/or zero carbon footprint buildings is at an all-time high. In Ireland, emissions from the residential sector contributed 24.8% of the total energy-related CO_2 emissions by sector (SEAI, 2018).

As demand for buildings increases globally due to a rising population and lower occupancy levels, particularly in the residential sector, the move towards more sustainable low carbon construction products and methods has become increasingly important to mitigate carbon emissions associated with construction and lifetime occupation. As part of this transition towards low carbon buildings, interest has grown in the use of natural building materials such as wood and hemp, which can sequester carbon during their growth and store it for the lifetime of the building.

Hemp lime buildings

Figure 12 shows an example of a hemp-lime building, 'The Renewable House' on the Innovation Park at BRE (Buildings Research Establishment) near Watford, Herts, constructed with hemp-lime walls. The Renewable House was constructed using Tradical® Hemcrete®.

Figure 12 (Photo: Lime Technology) The Renewable House' at BRE in Watford

The largest known hemp-lime building project in Ireland is in Carnlough, Co. Antrim, Northern Ireland. Drumalla Park, developed by Oaklee Homes Group, is one of only a few developments that achieved Level 4 of the 'Code for Sustainable Homes'. The development consists of ten two-bedroom semi-detached houses and one three-bedroom bungalow.

Ireland's first Hemp Passive House was completed in County Longford in 2012 by self-builder James Byrne. The two-story house was constructed in timber frame with a hemp-lime cast construction using the Tradical® Hemcrete® hemp-lime system from UK-based Lime Technologies. The walls including 450mm thick Tradical® Hemcrete® provides a u-value of 0.155 W/m^2K based on Passive House Institute calculations.

Many other examples of hemp-lime constructions, both small and large, are presented in the report by Daly et al (2012) – 'Hemp Lime Bio-composite as a Building Material in Irish Construction'.
http://www.equilibrium-bioedilizia.it/sites/default/files/allegati/Hemp%20Lime%20Bio-composite%20as%20a%20Building%20Material%20in%20Irish%20Construction.pdf

Further examples of Hempcrete constructions and building methods can be found using these links:

https://www.ciob.org/sites/default/files/NickNavasseminar140910.pdf

https://www.youtube.com/watch?v=YZAvYsAXwVM

Hemp lime concrete (hempcrete) construction

The hemp stem comprises fibres on the outside, and an inner woody core, known as shiv or hurd. Hemp hurds are used to produce concrete, known as 'hemp concrete or hempcrete', a bio-aggregate based product in which hemp hurds are mixed with lime-based binders and water. Hempcrete is primarily used for its thermal insulating and acoustic properties as it has low load-bearing capabilities compared to conventional concrete.

According to UK Hempcrete, 'Hempcrete' is a "better-than-zero-carbon material" because more atmospheric carbon is locked away in the material for the lifetime of the building than is used in its production and use.

A collaboration between Lhoist UK Ltd., Lime Technology Ltd and Hemcore Ltd led to the development of the registered trademark product Tradical® Hemcrete®, which is a blend of specially prepared hemp shiv (Tradical® HF) and a special lime-based binder (Tradical® HB). Together these products form a bio-composite building material that can be used both for the creation of buildings that have excellent thermal and acoustic properties as well as creating a healthy living and working environment (Hemp Lime Technology).

Lhoist has expertise as the largest manufacturer of lime in the world as well as many years' research and development experience of binders for hemp in France. Lime Technology specialises in the development of lime-based construction materials for environmental building uses. Hemcore is the pioneering company of growing and processing industrial hemp in the UK.

The hemp shiv forms the lightweight bio-aggregate, with the formulated lime as the binding agent and the water initially providing workability and hydration of the binder. The hemp-lime is normally mixed on a construction site by combining the binder and water in a pan mixer to create a slurry. Then the hemp shiv is added in and mixed to achieve a final hempcrete mix, suitable for placing into wall shuttering.

Tradical® Hemcrete® has three different hemp shiv:binder: water mix ratios (by mass) of 1:1:2, 1:1.5:2 and 1:2:3 to produce three different dry densities of 220, 275 and 330 kg/m^3. The proportion of lime binder used depends on the wall specification in terms of thermal mass, insulation, and acoustic requirements. Water is added to produce a workable wet hempcrete mix capable of being tamped into shuttered walls or sprayed applied. For a specific final dry density of hempcrete, the quantity of water required may be influenced by the water content of the hemp shiv.

Formulated lime binders such as Tradical® HB have been developed specifically for hemp aggregates. These binders are a dry blend of air lime (calcium hydroxide - Ca(OH)2), cement, pozzolanic material and other minor but important additives. As a result, most current hemp-lime construction projects use formulated binders. These binders contain varying quantities of hydraulic cement, pozzolans, and other additives to improve properties including dispersion and permeability (Hirst, 2013).

A hybrid wall construction comprising a timber frame structure with an in-situ hemp-lime wall mixture applied via filling/tamping in temporary shuttering or via spray application is currently the most common form of hemp-lime construction and is an alternative to the timber frame construction method (Daly et al., 2012).

Hempcrete walls construction methods include:

1. Tamping the wet hemp lime mix into pre-erected shuttering.
2. Spray application of the wet hemp lime mix; and
3. Off-site prefabrication of hemp-lime panels which are brought to the site for erection

Wall thicknesses can vary from 300mm to 500mm, depending on the building's thermal mass, insulation, and acoustic performance requirements. The above construction methods and final properties of the hemp-lime walls are not within the scope of this report. However, it can be said that hemp-lime construction in a single composite wall can meet or even surpass building regulation U-values and will have relevance for future housing stock in respect of the current Passive House standard of 0.15 W/m^2K.

Lime carbonation

Unlike conventional concrete, Hempcrete can be described as a 'carbon-negative building material because more carbon is taken out of the atmosphere in growing the hemp than is emitted in its production and application on-site.

Carbon is stored in the hemp shiv during the growth of the hemp plant. Shiv is the component of hemp that goes into making hempcrete. Once hempcrete walls are constructed, the carbon in the shiv is locked up for the lifetime of the building. However, additional carbon dioxide is

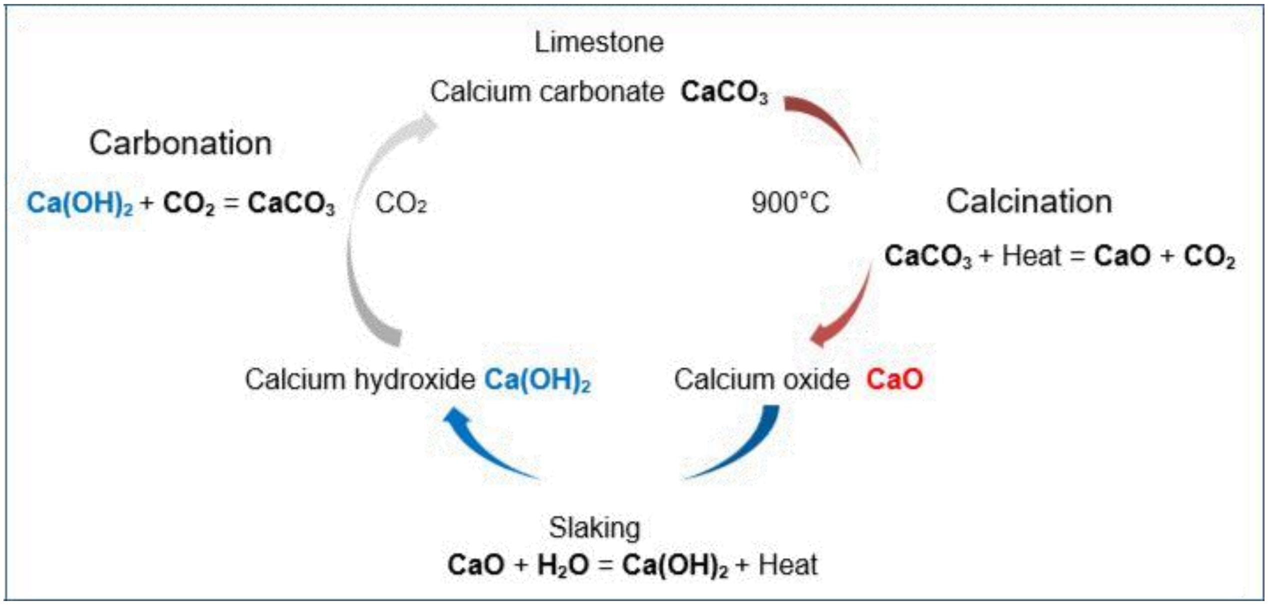


Figure 13 Limestone cycle showing the 'carbonation' process

reabsorbed by the lime-based binder used in the hempcrete mix in a process called 'carbonation' that produces Calcium carbonate or limestone. This process of reabsorption of CO_2 is the reverse of a process called 'calcination'. Calcination releases CO_2 from limestone (Calcium carbonate - $CaCO_3$) to produce Calcium oxide (CaO – burnt lime or quicklime), which when hydrated (added water - slaking) produces Calcium hydroxide ($Ca(OH)_2$ – hydrated or slaked lime, portlandite), the main constituent in Tradical® HB and other lime binder products.

The carbonation process occurs according to the following chemical equation:

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H2O$

Carbonation is a form of carbon storage and is a slow process that can take many months or even years depending on the wall density and porosity and the availability of air and moisture to the air lime $Ca(OH)_2$ binder embedded in the walls. The carbonation process is illustrated in Figure 13.

Hydraulic lime is a type of lime that sets in the presence of water due to the presence of impurities like aluminates and silicates. Non-hydraulic air lime (hydrated lime) requires air and sets through the process of carbonation.

Figure 14 shows the composition of Tradical® HB. This binder product contains 75% air lime, 15% hydraulic binder and 10% pozzolanic binder that imparts hydraulic properties on the air lime and allows it to harden through a combination of hydration and carbonation.

Hemp-lime is marketed as a carbon-negative building material and as such, it is assumed that 100% of the calcium hydroxide in the lime-based binder carbonates into calcium carbonate and is locked up in the building fabric (Hirst, 2013). However, in practice, this is unlikely to be the case and the amount of carbonation that occurs during the lifetime of hemp-lime buildings will depend on several factors including:

1. The proportions of hydrated and hydraulic of lime in the binder; and
2. The thickness, density and porosity of the wall allow air to penetrate.

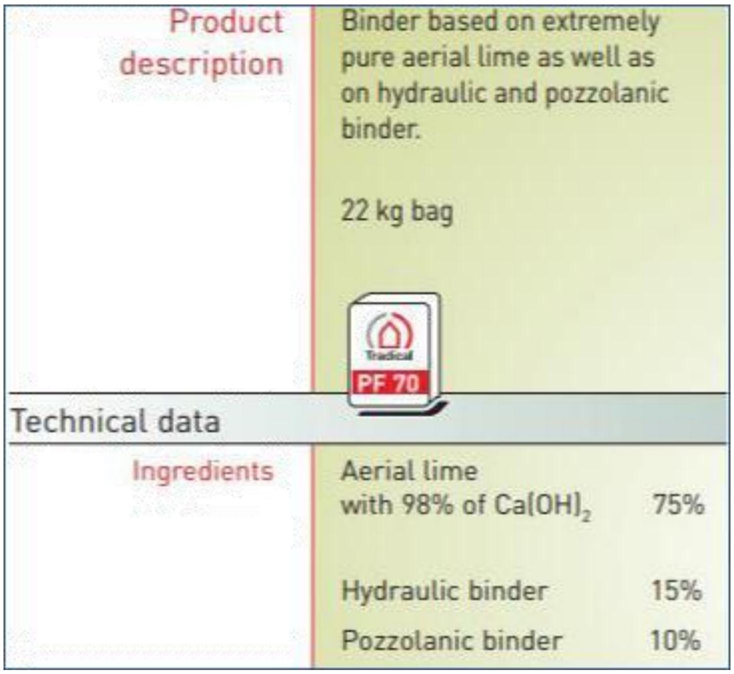


Figure 14 (Source: Lime Technology) Composition of typical lime-based binder

In a study by Pretot et al (2014) on the carbonation of the hemp binder Tradical® HB in hempcrete walls, it was assumed that over the building's lifetime (100 years), the total amount of carbon dioxide reabsorbed during carbonation would be the same as was released during calcination (594 g CO_2 per kg of hydrated lime). Furthermore, it was also assumed that only 60% of carbonation (106.9 g of CO_2 per kg) would occur for the hydraulic binder. In an earlier study by Lawrence (2006), carbonation in 360 days old pure lime mortar varied from 38.5 to 95.6% depending on the type of aggregate, the porosity and the fabrication and curing methodology of the mortars. Clearly, the level of carbonation achieved during the lifetime of hemp-lime buildings is difficult to quantify accurately and may only be an educated guess based on the information available on the amount and type of binder used.

d. Bioplastic

Hemp fibre as a bioplastic additive has immense potential, especially with the uptake in 3D printing and the local manufacture of components. These products are still in the research phase, IT Tralee is undergoing a feasibility study at present to identify potential uses.

e. Food/ fodder Co-products

The EHIA (EHIA, 2017a) reported that some companies also or exclusively processed hemp seeds or hemp flowers:
11,500 tonnes (compared to only 6,000 tonnes in 2010) seeds

240 tonnes (compared to only 7.5 tonnes in 2010) of flowers and leaves for medical applications (THC/CBD), food supplements (CBD) and the production of essential oil (for food and beverages) – 3,000% growth

The 2013 figures show a significant rise (92% growth) in the use of hemp seeds compared to the 2010 survey. Furthermore, the production of flowers and leaves increased by a huge 3,000%. Most of the hemp seeds are used as human food (about 60%) with the other 40% used as animal feed.

According to the EIHA (EIHA, 2017a), the growth area is in hemp oil for human nutritional and health products, as the oil contains an unusually high 90% unsaturated fatty acids like Linoleic acid (omega 6, essential), Alpha-linoleic acid (omega-3, essential), Gamma-linoleic acid (omega-6), as well as having an easily digested and well-balanced protein source. Bird and fish feed is the main market for hemp seeds in animal nutrition. Both birds and fish need fatty acids with a high share of omega-3 and omega-6 fatty acids for optimum development, both of which can be provided by hemp seeds.

Food sector opportunity for the hemp seed market:

Innovation in the Food Sector/ New product development/ Food technology
Financially viable and pertinent to the Irish market hemp applications include, but are not limited to, pharmacological products, automotive & advanced composite materials, supply chain, food & feed, drink, plastics & paper, waste management, renewable energy (carbon sequestration, pellets, biofuel etc.). All the above sectors have been estimated to attract more than €5 billion investment cumulative figure for each year (hemp industry only requires €151 million 3% of this annual investment to create aforementioned jobs, not including/accounting for the Agri sector).
https://www.ifc.org/wps/wcm/connect/f0be83804f7cdf68b7deff0098cb14b9/chapter3.pdf?MOD=AJPERES
https://assets.cdcgroup.com/wp-content/uploads/2018/06/25150849/Methodology-for-measuring-total-employment-effects.pdf
https://www.idaireland.com/invest-in-ireland/ireland-economy

"We have some great companies that are showing the way. Kerry Group is spending €135 million on its new research and development centre; Glanbia is an international leader in Global Performance Nutrition; Aryzta is a leading innovator in baked products; we have many excellent SME companies; and, of course, we are home to world-leading drinks brands such as Guinness, Baileys and Jameson." Deloitte Ireland, 2018.
https://www.independent.ie/business/irish/aib-and-isif-to-support-150m-renewables-fund-37514977.html
https://www.rte.ie/news/ireland/2019/0701/1059426-energia/

Employment in the agri-food sector accounted for 173,800 jobs, 7.9% of total employment, on average in 2017, according to the CSO Labour Force Survey.
https://ec.europa.eu/ireland/news/key-eu-policy-areas/agriculture_en
https://www.teagasc.ie/rural-economy/rural-economy/agri-food-business/agriculture-in-ireland/

https://www.agriculture.gov.ie/media/migration/publications/2019/IrishAgricultureFactsheetFullYear2018010519.pdf

https://www.centralbank.ie/docs/default-source/publications/economic-letters/vol-2018-no.8-irish-agriculture-economic-impact-and-current-challenges-(conefrey).pdf?sfvrsn=6
https://www.ifa.ie/wp-content/uploads/2019/01/IFA-AnnualReport-2018.pdf

- France/UK counterparts

a. Current market in France with hemp

In 2020, about 1,300 French producers cultivated 17,900 hectares (44,232 acres) that supplied six hemp cooperatives; those cooperatives produced 100,000 tons of defibered straw and 17,000 tons of seeds per year. Currently, France is the third-biggest producer in the world and the top producer in Europe. Over half of the land dedicated to hemp production in Europe is in France.
The plant is transformed into four products in France: hempseed (called chènevis in French), the chenevotte (shiv), fibre, and dust.

According to figures published in 2017 by French hemp producers and processors, 89 per cent of the weight (79 percent of the economic value) of the annual production from hemp cultivation in France is for straw and the remaining eleven percent (21 per cent in value) is hempseed.

https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Industrial%20Hemp%20in%20France_Paris_France_07-31-2021.pdf

b. Current market in UK with Hemp

Hemp cultivation is treated with caution in the UK and licenses are issued by the Home Office rather than the Department for Environment, Food & Rural Affairs (DEFRA), which manages most agricultural licenses. According to FOI requests from the Conservative Drug Policy Reform Group, only 33 licenses were issued for hemp cultivation in 2019, and DEFRA considers hemp to be a niche crop as so few farmers grow it. It is estimated that just 800 hectares of hemp is cultivated annually in the UK, compared to around 170,000 hectares apportioned for horticultural crops.

The current commercial uses of hemp involve producing oil from its seeds and using its fibres to make composites and other materials. Composites are an increasing area of interest since their inclusion in DEFRA's 2004 report on industrial uses of hemp. Hemp provides an alternative to the single-use plastics and synthetic fibres that pollute our oceans, through bio composites ranging from hempcrete to biodegradable plastics. This exceptionally versatile crop offers a multitude of environmental benefits, and has great potential for use as a phytoremediator, cleaning up soil and water contaminated with hazardous toxins. Hemp is carbon negative and its roots de compact the surrounding soil, improving the yield of subsequent crops.

https://hanwayassociates.com/news-opinion/uk-hemp

● Scalability of the Irish fibre crop/hemp industry

a. market size and value

In Ireland, interest in hemp has grown recently with the estimated area under cultivation at **567 acres (229.83 ha) in 2018, up from 76.45 ha (188.9 acres) in 2017,** according to the latest figures supplied by the Health Products Regulatory Authority (HPRA) of Ireland (DHM, 2018).

Clearly, the above figures confirm that there is a resurgence in global hemp cultivation. Hemp has considerably more potential globally for bioenergy, construction products, biocomposites and other materials, and nutritional and pharmaceutical health products for both humans and animals, than is currently being realised. Future expansion of hemp cultivation and of the global hemp industry will depend on individual country policy and regulatory changes that support a drive towards reduced fossil fuel dependency.

b. Industry processing capacity

Hemp is an annual crop and can be harvested from around 110 days after sowing depending on end use and weather conditions. Various studies on growing hemp have reported a wide range of hemp yields in different countries. Crowley (2001) reported hemp yields in Ireland of up to 14 tonnes of dry matter per hectare (14 t DM/ha) and Van der Werf et al. (1996) reported yields up to 17.1 t DM/ha in the Netherlands. More recent hemp trials in Ireland in 2008, 2009 and 2010 investigated the optimal nitrogen fertilization rate for hemp biomass production (Finnan and Burke, 2013). Three different varieties of hemp were used in 2008 at three different sites (Oak Park, Knockbeg and Edenderry), with the latest maturing Futura 75 achieving the highest average total yield of 12.2 t DM/ha, with the stem yield averaging 10.5 t DM/ha. Subsequently, only Futura 75 was planted on two sites (Oak Park and Knockbeg) in 2009 and 2010. In 2009, average total yields were 8.9 and 11.5 t DM/ha at Oak Park and Knockbeg, respectively. The lower yield at Oak Park in 2009 was primarily attributed to bird damage. In 2010, average total yields were 13.5 and 12.6 t DM/ha at Oak Park and Knockbeg, respectively. Overall, in this study, hemp biomass yield increased up to an application rate of 120 kg Nitrogen per hectare (kg N/ha).
In a 3-year trial (2006–2008) in the south of Sweden, an average hemp biomass yield of 16 tonnes dry matter (DM) per hectare was reported from an autumn harvest (Kreuger et al., 2010), while a yield of 10 tonnes DM/ha was reported from the north of Sweden (Finell et al., 2006). Sweden has a cold climate without a dry season, with warm summers in the south and cold summers in the north. It seems that climate plays an important part in the yield potential of hemp, even within the same country.

In a 2015 trial in Kentucky, USA, Cannabis sativa L., cv Futura 75, a late-maturing hemp cultivar, was seeded at 66kg/ha and nitrogen applied at 55kg N/ha before plant emergence. The yields after 110 days were 5,347 kg DM/ha of biomass stem and 1,230 kg DM/ha of seed (Das et al., 2017). This biomass yield was less than half of that achieved with the three-year trials conducted in Ireland from 2008 to 2010, where the seed rate was only 30 kg/ha and optimal nitrogen application was 120 kg N/ha. Sowing at a seeding rate of 30 kg/ha was previously found to give the highest biomass yields (Crowley, 2001).

Kreuger et al. (2010) cited other examples of higher hemp yields of around 20 tonnes DM/ha in temperate regions of Europe, including Italy, the Netherlands and the United Kingdom. Sipos et al. (2010) concluded that when using hemp as a biomass source for fuel production rather than as a fibre crop, harvesting should be postponed for 1 to 2 months to achieve the highest biomass yield.

In a 3-year trial in Sweden by Prade et al. (2011), investigating biomass and energy yield of industrial hemp grown for biogas and solid fuel, the earlier sowing date in 2007 than in 2008 and 2009 potentially explained the DM yield differences between 2007 and the two following years. This explanation was supported by findings from earlier studies, where later sowing dates resulted in lower DM yields in the magnitude of 3 to 4 tonnes/ha for one month of delay. However, there may be other factors such as rainfall and soil moisture deficit, which may be important in determining dry matter yields in particular years, regardless of sowing date. In Ireland, the late spring in 2018 delayed the sowing of hemp crops and the subsequent dry summer would have adversely affected growth rates and final hemp yields.

In the Swedish studies, the average hemp yield of 16 tonnes per hectare DM was achieved with high inputs of nitrogen (115 to 200 kg N/ha) and was harvested about 150 days after sowing. Nitrogen inputs may be lower in Ireland and therefore yield expectations should be set at a more realistic level in determining potential hemp ethanol yield per hectare that is sustainable year on year. In this context and based on the 3-year trials in Ireland, using average hemp stem yields of 10 to 12 tonnes per hectare DM would seem more appropriate.

SWOT analysis

Strengths

(See Protein submission in Appendix)

1. Environment

Soil regeneration/ decontamination

Industrial activities have a detrimental impact on the environment and health when high concentrations of pollutants are released. Phytoremediation is a natural method of utilizing plants to remove contaminants from the soil. The goal of this study was to investigate the ability of Cannabis sativa L. to sustainably grow and remediate abandoned coal mine land soils in Pennsylvania. In this study, six different varieties of industrial hemp (Fedora 17, Felina 32, Ferimon, Futura 75, Santhica 27, and USO 31) were grown on two different contaminated soil types and two commercial soils (Miracle-Gro Potting Mix and PRO-MIX HP Mycorrhizae High Porosity Grower Mix). Plants growing in all soil types were exposed to two environmental conditions (outside and in the greenhouse). Seed germination response and plant height indicated no significant differences among all hemp varieties grown in different soils, however on an average, the height of the plants grown in the greenhouse exceeded that of the plants grown outdoors. In addition, heavy metal analysis of Arsenic, Lead, Nickel, Mercury, and Cadmium was performed. The concentration of Nickel was 2.54 times greater in the leaves of hemp grown in mine land soil outdoors when compared to greenhouse conditions. No differences were found between expressions of heavy metal transporter genes. Secondary metabolite analysis of floral buds from hemp grown in mine land soil displayed a significant increase in the total Cannabidiol content (2.16%, 2.58%) when compared to Miracle-Gro control soil (1.08%, 1.6%) for outdoors and in the greenhouse, respectively. Molecular analysis using qRT-PCR indicated an 18-fold increase in the expression of the cannabidiolic acid synthase gene in plants grown on mine land soil. The data indicates a high tolerance to heavy metals as indicated from the physiological and metabolites analysis."

Source:

Husain R, Weeden H, Bogush D, Deguchi M, Soliman M, Potlakayala S, et al. (2019) Enhanced tolerance of industrial hemp (Cannabis sativa L.) plants on abandoned mine land soil leads to overexpression of cannabinoids. PLoS ONE 14(8): e0221570.
https://doi.org/10.1371/journal.pone.0221570

Carbon sequestration - GHG abatement from crop

Carbon dioxide sequestration by hemp

Based on various studies, it would seem appropriate to use an average carbon content figure to calculate the amount of carbon dioxide theoretically sequestered by a crop of hemp. In this respect, it was decided to use a carbon content of 46%.

The amount of carbon dioxide sequestered from the air and temporarily stored in one tonne of hemp stem can be calculated as follows:

1. The molar masses of carbon and carbon dioxide are 12 and 44 kg mol^{-1}, respectively. Therefore, assuming that all carbon in the plant is taken from CO_2 in the air, 3.67 kg of CO_2 is sequestered for each 1 kg of carbon present in the plant.
2. Assuming a carbon content of 46%, each kg of hemp stem will contain 0.46 kg of carbon.
3. Therefore, 1 tonne (1,000 kg) of hemp stem will contain 0.46 tonnes (460 kg) of carbon.
4. Hence, every tonne of hemp stem dry matter will have absorbed 1.68 tonnes of CO_2 (460 kg carbon x 3.67 kg CO_2 /kg carbon = 1.68 tonnes CO_2).

Assuming an average hemp stem yield of 10 tonnes DM per hectare, the total amount of carbon dioxide potentially sequestered can be calculated as shown in Table 8

Table 9 Carbon dioxide sequestered by 10 tonnes/ha of hemp stem DM

	tonnes/ha
Total Carbon dioxide per tonne of hemp stem DM	1.68
Total hemp stem DM yield	10.00
Total Carbon dioxide (CO_2) sequestered per hectare (1.68 tonnes CO_2/tonne hemp stem DM x 10 tonnes hemp stem/ha)	16.80

In Ireland, a crop averaging 10 tonnes per hectare hemp stem dry matter could potentially sequester approximately 17 tonnes of CO_2. However, as the yield of hemp is variable year on year due to climatic factors, the actual amount of CO_2 sequestered will vary depending on the carbon content of the hemp stem and its total dry matter yield per hectare. Figure 15 shows the potential carbon sequestration (abatement) delivered by hemp for a range of yields.

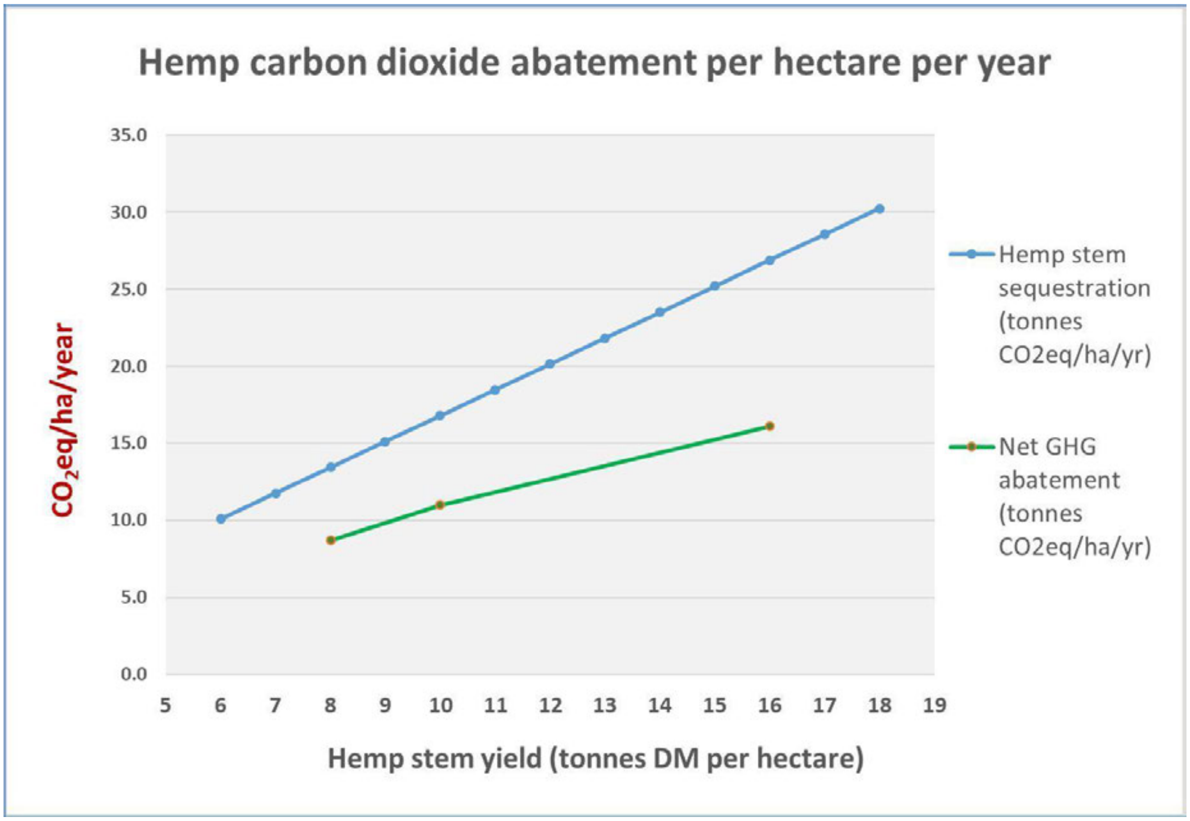


Figure 15 Hemp carbon dioxide abatement per hectare per year

Figure 15 shows a linear relationship between the amount of CO_2 sequestration (blue line) and the hemp stem dry matter yield. This assumes that the carbon content of the stem dry matter remains constant at 46% across the yield range (6 to 18 tonnes DM/ha). Based on the above yield range, hemp stems could potentially sequester 10 – 30 tonnes of CO_2 per hectare. However, this does include carbon emissions associated with fertilizer and other inputs, and fuel for crop cultivation, harvesting and processing.

Carbon can also be stored in the tap root of hemp which remains below soil level. Some of this carbon may remain in long-term soil storage. However, under arable conditions, it is likely that most of the carbon will be mineralized and oxidized following cultivation operations and therefore not contribute to long-term sequestration (Finnan and Styles, 2013). Based on the above assertion, net carbon gain in soils is assumed to be zero where hemp is included in an arable rotation.

In Ireland, Finnan and Styles (2013) carried out a detailed investigation of the sustainability of hemp as an annual crop in terms of climate and energy policy compared to other energy crops. In this study, annual Greenhouse Gas (GHG) emissions for hemp were compared with a range of annual crops (sugar beet for bioethanol and oilseed rape for biodiesel + electricity) and perennial crops (willow and miscanthus for solid fuel) using a Life Cycle Assessment (LCA) analysis over an average 21-year period (as willow and miscanthus are expected to remain viable for this length of time). GHG emissions associated with the production of inputs (seed, fertilizer, chemicals, etc,), transport operations, fuel for field operations (ploughing, tilling, sowing, fertilizer application, rolling and harvesting) and crop processing were all included in the LCA.

Figure 16 shows the results of GHG abatement attributable to the energy chains of each crop in the study by Finnan and Styles (2013). Hemp had a net GHG abatement of 11 tonnes CO_2eq/ha/year for the mid-range hemp stem yield of 10 tonnes DM/ha; this was 140% greater than for oilseed rape energy chains and 540% greater than for the sugar beet ethanol fuel chain, based on their mid-range yields. Net GHG abatement for hemp ranged from 8.7 to 16.1 CO_2eq/ha/year over the yield range of 8 to 14 tonnes DM/ha/yr.
These GHG abatement results have been superimposed onto Figure 10 (green line) to show the relationship between hemp stem carbon sequestration and GHG abatement.

Finnan and Styles (2013) also reported that net GHG abatement for hemp was lower than both willow and miscanthus when these crops were planted on arable land. However, when planted on grassland, willow and miscanthus had lower net GHG abatements compared to hemp (See Figure 16). The study also reported that average hemp cultivation emissions of almost 3 tonnes CO_2eq/ha could be reduced by up to 1.5 tonnes CO_2eq/ha by substituting inorganic (mineral) fertilizers for organic fertilizers such as farmyard manure and slurry. This would mainly result from indirect emissions savings from displaced fertilizer manufacture and reduced soil nitrogen dioxide release from mineral fertilizer application.

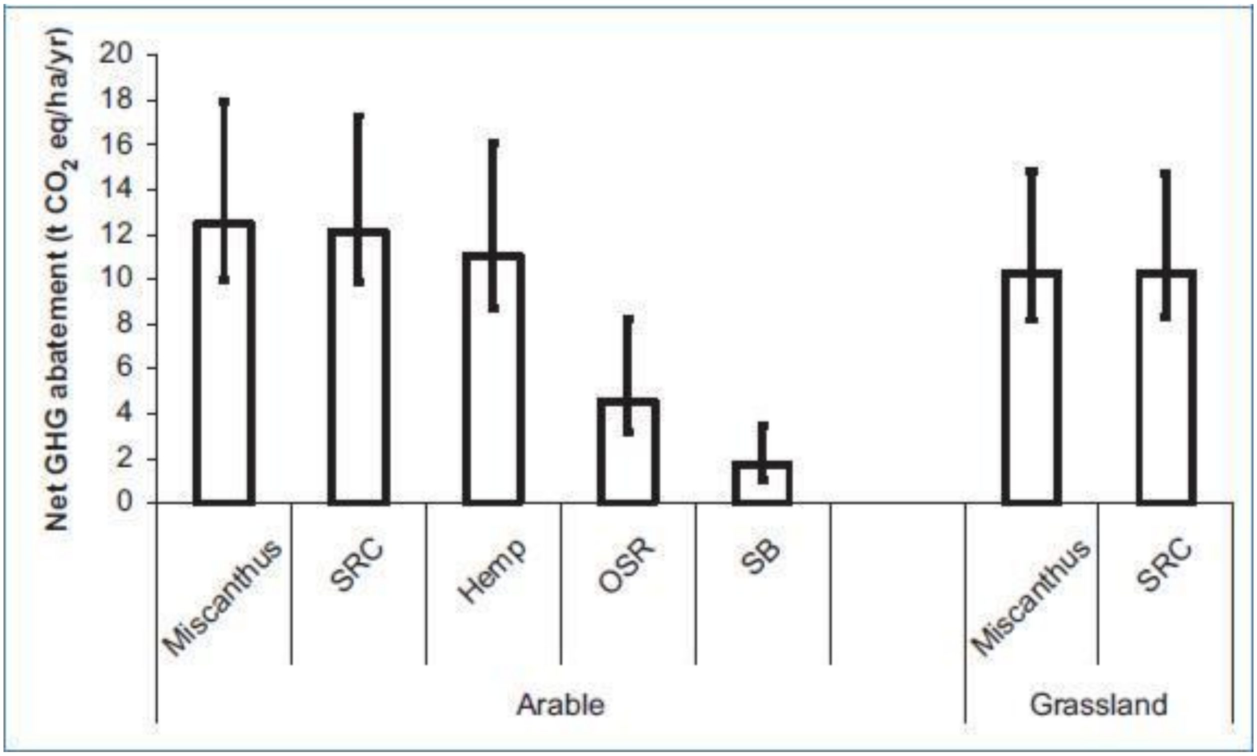


Figure 16 Carbon sequestration - Carbon Capture and Storage (CCS)

Source: Finnan and Styles, 2013

Carbon storage and carbonation per cubic metre of hemp-lime walls

Hemp lime wall mixes have typically used two parts (by mass) of binder to one part of shiv, mixed with approximately 3 parts of water. This mix, when correctly tamped on-site, produces a dry density of around 330kg/m^3. To reduce the proportion of binder and limit the degree of material compaction, the final density of the material can be reduced, thus improving the thermal insulation, and reducing the overall embodied energy, mainly due to reduction in the binder used.

The reabsorption of carbon dioxide (released during calcination) through carbonation is a complex chemical process. The rate of carbonation is highly dependent on the rate of diffusion of CO2 into the hemp-lime, which is affected by the thickness, type, and porosity of the wall as well as climatic conditions including temperature and humidity. Therefore, it is difficult to predict accurately the actual amount of carbonation in hemp-lime buildings over their lifetime.

Lime Technology Ltd has calculated carbon sequestration (carbon capture in shiv + lime carbonation) figures for Tradical® Hemcrete®. Values for shuttered and cast Hemcrete® range from 110 to 165 kg of CO2 per m^3 depending on the level of compaction during construction

(Hemp Lime Technology). Furthermore, Spray applied Hemcrete® sequesters around 110kg of CO_2 per m^3.

Several studies have been carried out in different countries to attempt to quantify carbon storage and lime carbonation associated with hemp-lime walls. For example, in the UK, Ip and Miller (2012) studied the life cycle GHG emissions of hemp-lime wall constructions. The functional unit was a 1 m × 1 m × 0.3 m (thick) vertical hemp-lime wall and has a density of 275 kg/m^3. It was made up of 30 kg hemp shiv, 50 kg lime binder plus 75 kg water for the hemp-lime mix. Two pieces of 1 m × 100 mm × 50 mm kiln dried sawn timber were embedded in the functional unit to provide structural support. A full Life Cycle Assessment (LCA) was performed using LCA software SimaPro and emissions data for all elements of the hemp-lime wall, including growing, processing, and transporting the hemp, and production of the binder. The calculated total carbon sequestration (carbon storage + lime carbonation) of the functional unit (1 m × 1 m × 0.3 m) was 82.71 kg CO_2e, equivalent to 275.7 kg CO_2e/m^3. GHG emissions associated with the materials making up the functional unit were 46.63 kg CO_2e, giving a Net life cycle GHG emissions factor of – 36.08 kg CO_2e (82.71 – 46.63 kg CO_2e), equivalent to –120 kg CO_2e/m^3. Ip and Miller (2012) concluded that “Using hemp shiv to store carbon is effective and the overall impact of hemp-lime wall construction is positive to the environment.”

In another study, in India, Jami and Kumar (2017) used hemp-lime test blocks (7 cm x 7 cm x 7 cm) and measured carbon sequestration after 28 days at 307.26 kg CO_2/m^3 of hemp-lime concrete at a dry density of 567.05 kg/m^3. However, the predicted theoretical figure (based on 100% carbonation of lime over the lifetime of a building) was 449.8 kg CO_2/m^3 Net GHG emissions were not assessed in this study.

From the results above, it is evident that the level of carbon sequestration in hemp-lime walls can vary significantly from study to study due to variations in the quantities of hemp shiv and lime in the wall mix, thickness, porosity, and age of the walls, and in the overall methodology and scope of each study. In theory, the total quantity of carbon dioxide that can theoretically be stored in a hemp-lime wall can be calculated from:

1. the amount of carbon in the hemp shiv and
2. the amount of carbonation of lime.

Table 9 shows the calculated theoretical lifetime (100 years) amount of carbon dioxide sequestration (carbon storage in the shiv and carbonation from the binder) per cubic metre of hemp-lime wall (excluding lime rendering). The calculations are based on known amounts of materials required to achieve final wall dry densities of 275 and 330 kg/m^3, assuming hemp shiv and binder are supplied in 20 kg and 22 kg bags, respectively. To simplify the calculations, the above amounts equate to 1 part shiv and 1 part binder, respectively. It has also been assumed that 100% of the air lime and 60% of the hydraulic lime carbonate over the lifetime of the walls.

The theoretical lifetime total carbon sequestration (carbon storage and carbonation) of 275 and 330 kg/m^3 dry density hemp-lime walls were 228 and 255 kg CO2e/m^3, respectively. The carbon sequestration figure for the 275 kg/m^3 density wall was approximately 50 kg CO2e/m^3 lower than Ip and Miller's figure of 275.7 kg CO2e/m^3 for their 275 kg/m^3 density wall. The quantities of shiv and binder used by Ip and Miller were the same as in the Table 6 calculation, the only variation being in the amount of water used. The binder also had the same proportions by mass (75% of hydrated lime, 15% of hydraulic lime and 10% of pozzolans and other additives).

The difference between Ip and Miller's results and the calculated result in Table 6 has been determined. Ip and Miller used:

1. Hemp shiv carbon capture of 1.84 kg CO2/kg hemp (184 CO2e/m^3), compared to 1.68 kg CO2/kg hemp shiv (147 CO2e/m^3) in Table 6, and

2. Lime carbonation of 95 kg CO2e/m^3, compared to 81 kg CO2e/m^3 in Table 9.

The main difference is in carbon capture by the embedded hemp shiv. Ip and Miller used Bevan and Woolley (2008) for the reference carbon content for hemp shiv (50.1% carbon, equivalent to 1.84 kg CO2/kg hemp), whereas this study has used a figure of 40% carbon for the calculation in Table 6. The carbon content of shiv was reported as 45.4% on a dry matter basis by Jami and Kumar (2017) and 44.5% by Jankauskiene et al., (2014). In this study, an average of 45% carbon was used and adjusted to 12% moisture content (40% carbon content) to allow for the fact that hemp shiv is not completely dry when sold as a building product.

Table 10 Theoretical lifetime total carbon sequestration (carbon storage and carbonation) in 1m³ of hemp-lime wall at 275 and 330 kg/m³ dry density.

Quantities equivalent to 1 m^3 of hemp-lime wall	Hemp lime wall Dry Density 275 kg/m^3	Hemp lime wall Dry Density 330 kg/m^3
Ratios (by mass) Shiv:binder: water	1:1.5:2	1:2:3
Shiv (kg)	100	100
Binder (kg)	165	220
Water (kg)	200	300
The carbon content of oven-dry shiv (% DM)	45	45
The carbon content of shiv @ 12% moisture content (%)	40	40
Carbon stored in shiv (100 kg x 0.40) (kg)	40	40
CO_2 equivalent stored in shiv (40 kg x Carbon x 3.67*) (kg)	147	147
Air lime available for carbonation (75% inclusion and 98% of $Ca(OH)_2$) (kg)	121	162
Hydraulic lime available for carbonation (15% inclusion and 60% of $Ca(OH)_2$) (kg)	15	20
Total lime available for carbonation (kg)	136	182
CO_2 equivalent in carbonation (kg lime x 0.59***) (kg)	81	108
Total Carbon dioxide (Capture + Carbonation) per cubic metre of hemp lime wall (kg CO_2e/m^3)	228	255

The molar masses of carbon and carbon dioxide are 12 and 44 kg/kmol, respectively, i.e. 3.67 kg CO_2 per kg Carbon

** Assumes 100% carbonation of the air lime and 60% carbonation of the hydraulic lime

*** The molar masses of calcium hydroxide and Carbon dioxide are 74 kg/kmol and 44 kg/kmol, respectively, i.e. 0.59 kg CO_2 per kg $Ca(OH)_2$

Carbon storage and carbonation in a small, detached hemp lime house

Using the data in Table 9, the amount of carbon stored in the walls of a typical small, detached house can be calculated as shown in Table 10.

Table 11 Carbon sequestration in a small, detached hemp lime house with 150 m^2 wall area

Wall area	= 150 m^2
Wall thickness	= 300 mm
Volume of hemp lime concrete	= 45 m^3
Hemp lime wall dry density	= 275 kg/m^3
Total quantity of hemp shiv used	= 4.5 tonnes (225 bales x 20 kg)
Carbon capture (CO2e) in shiv	= 6.6 tonnes (147 kg CO2/m^3 x 45 m^3)
Total quantity of lime binder	= 7.4 tonnes (336 bags x 22 kg)
Carbonation (CO2e) of lime binder	= 3.6 tonnes (81 kg CO2/m^3 x 45 m^3)
Total carbon sequestration	
(Carbon capture + Carbonation)	= 10.25 tonnes CO2e

Using Ip and Miller's (2012) data in the example above, the total carbon sequestration would have been approximately 20 per cent higher at 12.4 tonnes CO2e. Furthermore, using the corresponding Net GHG emissions factor of –120 kg CO2e/m^3, the Net Life Cycle GHG emissions would equate to – 5.4 tonnes CO2e (–120 kg CO2e/m^3 x 45 m^3) for a typical small, detached house. This means that 5.4 tonnes of CO2 is locked up in the house over the building's life cycle, net of the emissions associated with hemp and lime production and processing, transport to site and construction.

A crop of hemp yielding 10 tonnes DM/ha will provide 5 to 6 tonnes of a processed shiv. Therefore, an area of between 0.75 to 0.9 hectares of land would be required to provide enough shiv (4.5 to 5 tonnes) to build one small hemp-lime detached house, as detailed in Table 10.

Embodied energy and carbon

Embodied Energy (EE) is the amount of energy consumed by all the processes associated with the production of a building product or indeed a whole building. EE can include energy consumed in mining and processing of natural resources such as limestone, manufacturing, transport, construction, lifetime energy consumption during occupation and energy to dispose of the products or whole building. This is sometimes referred to as the 'cradle to grave' approach to calculating embodied energy in buildings. However, some materials such as hemp-lime can be reprocessed into new building materials or recycled in a 'cradle to cradle' approach, thus reducing the embodied energy.

Embodied Carbon (EC) refers to carbon dioxide emitted during the manufacture, transport and construction of building materials, together with carbon emissions during the occupation of the building and end of life demolition emissions. Reusing or recycling building materials can reduce the embodied carbon of demolition.

Embodied energy and carbon in hemp-lime construction

There is limited scientific information available on Embodied Energy of hemp-lime construction. However, Florentin et al., (2017), cited two different publications by Wilkinson (2009) and Busbridge and Rhydwen (2010), which reported similar Embodied Energy values of 3.3 and 3.5 MJ/kg for hemp-lime composites with densities of 300 and 330 kg/m^3, respectively. According to Florentin et al., (2017), embodied carbon of hemp-lime construction has been more extensively studied, giving rise to negative embodied carbon figures in the range – 0.3 to – 1.0 kg CO2/kg.
For the small, detached hemp-lime house in Section 5.5, the calculated EC over its lifetime was – 120 kg $CO2e/m^3$, which would equate to – 0.44 kg CO2e/kg of hemp-lime wall. This is within the range reported by Florentin et al., (2017) for other studies.

Biodiversity

Hemp is an extremely positive crop for the environment. It is reported that hemp biomass has the lowest impact on the environment when parameters such as soil compaction, agro-biodiversity, nutrient depletions, and pesticides application are considered (Agustin Gonzalo Miguel Garcia, 2017).

Soil benefits

Hemp cultivation requires no fungicides, herbicides, or insecticides as it is naturally resistant to fungus, insects and other pests (Crowley, 2001). It is a rapidly growing plant that becomes tall and thick quite quickly. This in turn suppresses weed development. The roots can draw up nutrients deep within the soil which would have been otherwise lost through leaching. The hemp crop removes heavy metals from the soil while its deep tap roots, approximately 2.5 metres in depth, help to aerate the soil. Hemp also leaves the land in a more workable condition for the next growing season, and it increases the yields of the subsequent crops by 15-25%. It achieves this by depositing 60% of the nutrients it extracted from deep in the soil back onto the surface of the soil in the form of its leaves before it is ready to harvest. All these attributes make hemp an ideal crop to cultivate on an organic farm (Angelova et al., 2004)(O'Connor, 2007)(Agustin Gonzalo Miguel Garcia, 2017).

Hemp benefits to the declining bee population

Declining bee numbers are a hot topic in Ireland in recent months and hemp cultivation can help address this problem. Over the last 50 years, there has been a wide-scale loss of wind pollinators and in Ireland, one-third of our 99 species are threatened with extinction (Department of Agriculture, 2019). Bees are essential as they help pollinate both crops and native plants, making them of huge economic and ecological importance to Ireland (The National Biodiversity Data Centre, 2010). Because hemp plants are wind-pollinated, dioecious, and staminate, they produce large amounts of pollen which in turn are attractive to bees. Hemp flowering normally occurs between the end of July and the end of September. This period coincides with a scarcity of pollinator-friendly crop plants in Ireland, making hemp flowers a potentially valuable source of pollen for foraging bees which can help in the future survival of the bee population in Ireland (O'Brien and Arathi, 2019).

The plant has also evolved to be a natural repellent against harmful insects as it secretes important secondary metabolites such as volatile terpenes and cannabinoids. Therefore, the essential oil from the inflorescences can be extracted and used as a botanical insecticide. The extraction can be performed via stream distillation. Recent studies have shown that this oil can be toxic to aphids, house flies and larvae while being non-toxic to ladybugs and earth worms (Benelli et al., 2018). These studies prove that the essential oils extracted from the inflorescences of the hemp plant can be utilised as an environmentally friendly insecticide that can be useful in organic agriculture.

Hemp: A Sustainable crop

Currently, in Ireland, there is a big focus on sustainability, carbon emissions, plastic-free food products and environmentally friendly products. According to Correa et al, for a product to be considered sustainable, it must meet at least three of each of the demands in each circle shown in Figure 17 (Correa, et al., 2019). Hemp meets all the criteria required.

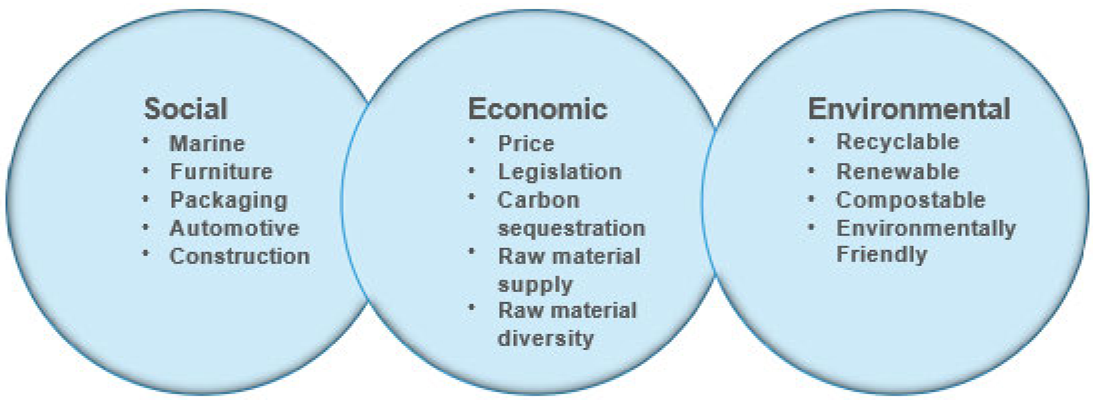


Figure 17 Criteria for a sustainable product.

Adapted from (Correa, et al., 2019)

In July 2018 a joint committee on Agriculture, Food and the Marine produced a paper on "Climate Change and Sustainability in the Agriculture and Food Sectors". It was recommended that resources should be provided to enhance the research into the potential of crops such as hemp to be utilised as bioplastic, which is a biodegradable replacement for conventional plastics (Joint Committee on Agriculture and Climate, 2018). Experts suggest that this plastic will fully break down between 3 and 6 months.

Carbon dioxide (CO_2), methane (CH_4) and nitrogen (N_2O) are considered the major inputs and sinks of greenhouse gases (GHGs) (Finnan and Burke, 2013a). As shown in Figure 18, agriculture was responsible for 33.3% of Irelands total greenhouse gas emissions, making it the largest contributing sector overall (EPA, 2018). The other main contributors were the transport industry (19.8%) and the energy industries (19.3%). This puts pressure on the agriculture sector to reduce its emissions especially as Ireland has made a commitment to reduce its greenhouse gas emissions by 20% by the year 2020 and under the current EU Effort Sharing Decision, a target of 30% reduction has been set for 2030 (Lynch et al., 2019). Hemp is a carbon sequester, absorbing

10 tonnes of CO_2 per ha. This in turn can aid the Irish agriculture sector to meet its stringent targets (Finnan and Styles, 2013).

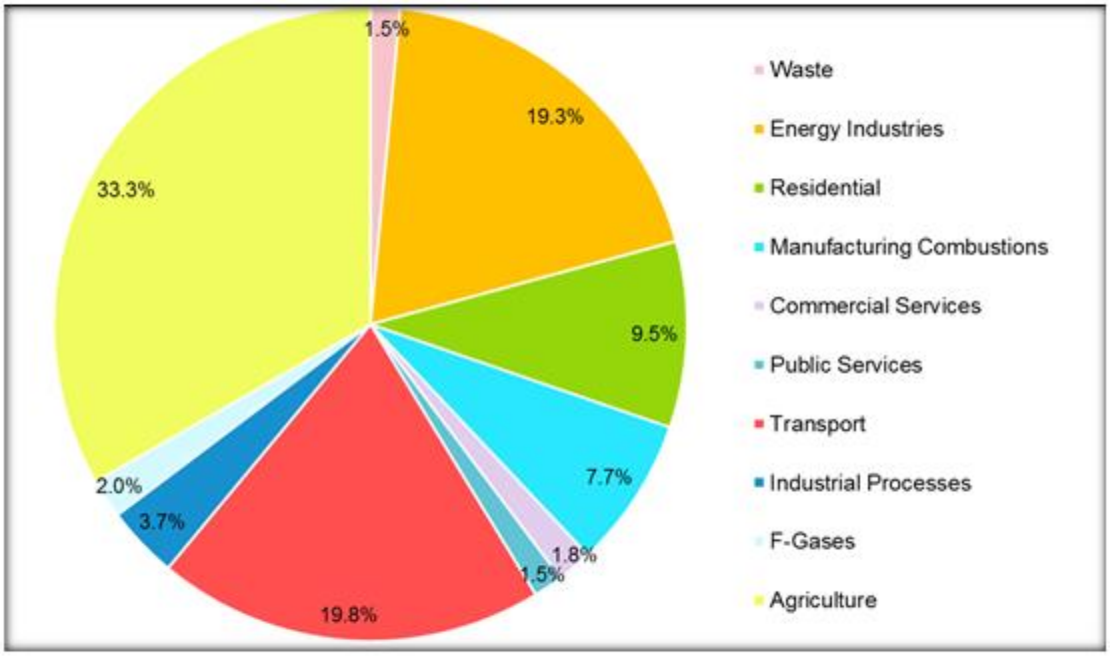


Figure 18 Ireland's greenhouse gas emissions 2017.

Source: (EPA, 2018)

In addition, fossil fuel is a limited resource which is depleting at a swift rate due to the ever-increasing demand for it. The burning of this fossil fuel is being held responsible for the increase in greenhouse gas emissions which in turn is having a negative impact on climate change. This overreliance can be overcome by developing alternative renewable fuels which are less harmful to the environment. Using hemp to develop this alternative fuel can improve energy security and can decrease the susceptibility of the current fuel supply (Alcheikh, 2015) (French, 2019).

The European Innovation Partnership 'Agricultural Productivity and Sustainability (EIP AGRI) was set up to help create competitive and sustainable farming and forestry that 'achieves more from less'. It ensures that there is a steady supply of food, feed and biomaterials while keeping an eye on the essential natural resources that farming depends on. They have a Bio-Based Industry (BBI) demonstration project set up entitled 'Growing advanced industrial crops on marginal lands for bio refineries. In this project, marginal land which is not considered acceptable for food or feed crops is used to cultivate hemp and miscanthus. Marginal land is defined as land that has low soil fertility or where socio-economic constraints hinder the cultivation of food or feed crops. This can also include land that is polluted by heavy metals or contaminated land. The aim of the project is to make use of unused, marginal, or contaminated land to produce commercial cultivars which can be done feasibly and will have multiple ends uses. The lands performance in the value chain is also included along with their economic and environmental profile (Argyropoulos, 2019). Climate change studies carried out in 2015 show that by mid-century, there will be a mean increase of 1-1.6°C to annual temperatures in Ireland. Daytime temperatures are expected to rise by 0.7-2.6°C in the summer. Consequently, this will increase the growing season by 35-40 days per year. This means that will be less of a factor when it comes to growing crops successfully in Ireland each year (Nolan, 2015).

2. Socio-Economic

Assessment of Socio-economic impact - uncertainty in the Irish agriculture sector

There are several factors in place which are causing deep levels of uncertainty within sectors of Irish agriculture. While some of these challenges are recent phenomena such as the threats posed by Britain's exit from the European Union, others are more structural in nature and have been festering over a longer period. In 2010, 70% of sectoral income in agriculture, fisheries and food came from subsidies (Devaney & Henchion, 2017 p.224). One sector where the difficulties facing Irish agriculture are particularly evident is in the beef sector. Exposure to price volatility has been presented as a 'key threat to family farm viability' (Hooks, et al., 2017 p.65). While the pressures facing beef farmers have been widely noted in the Irish media in recent times, sheep farmers are also facing a precarious financial future. The divide in Irish agriculture also aligns with the geographical differences in Ireland with farmers in more remote areas in the midlands and west-facing greater challenges due to lower levels of off-farm employment available in these areas. An additional challenge facing agriculture is the increasing scrutiny it faces regarding the need to minimise GHG emission creation (O'Brien, et al., 2014 p.108).

The 'Just Transition'

For Ireland's agriculture sector to grow in a more sustainable manner, it is important that changes introduced do not damage the social or economic well-being of farmers. One means of achieving this is by implementing a just transition. The intention of a just transition is to ensure that communities that have been dependent on pollutant forms of employment (i.e. fossil fuel extraction as well as agriculture) are supported in the transition towards more sustainable sources of employment or greener land-use practices. Implementing a just transition was identified by the Paris Climate Agreement as an essential element of climate action (Doorey, 2017). A central aspect in creating a just transition is ensuring that communities, workers, and farmers are provided with the ability to shape how this transition will take place. Given the challenges facing certain sectors in Irish agriculture, it is possible that a transition from traditional land-use practices towards the planting of hemp and flax can create more secure futures for farmers. This can create a double dividend whereby farmer incomes and rural development prospects are enhanced while environmental goods are provided, and natural habitats are protected. Growing hemp and flax on peatland can support the growth of the bioeconomy in Ireland by providing the biomass needed to reduce the reliance placed on fossil-based products while also creating new revenue streams for farmers.

Job creation

It is the intention of HCI to provide an immediate and lasting positive environmental impact, by reducing the amount of high-polluting fossil fuels required for industrial processes (e.g. building insulation/ materials, clothing, foodstuffs and non-woven fibre products). Of equal importance is the potential of hemp for rural regeneration and the recreation of supporting industries that used to be prevalent in the country.

An indigenous hemp industry in Ireland has the potential to create 80,000 rural jobs according to a recent report by a Teagasc Specialist. Teagasc has been involved in research into hemp – a strain of the Cannabis sativa plant grown specifically for Industrial uses – since the 1960s. Barry Caslin, a Teagasc specialist in energy and rural development urged the government to embrace the crop's potential as global demand for its components escalates at a rapid rate.

In 2019, HCI board member Eoin Carew independently completed a thesis entitled "Hemp-Growing - An Alternative Income for Irish Farmers". A key finding from this report is that:

"Only 5% of farmers are under 35 and 30% of farmers are over 65. Therefore, there need to be as many incentives as possible to entice young people to become farmers and for this occupation to be a long-term source of income" (CSO, 2016)

Based on the market share entry levels for the hemp industry and having analysed the potential of the hemp industry on the Irish market, applicable hemp industry segments suitable for the Irish market: construction, pharma, agriculture, food and drink, feed - which seek investment of €15 billion or more annually in Ireland (sources vary and some sectors do not have up-to-date stats for Ireland, therefore a lesser figure that can be crossed checked was applied - pessimistic approach). It was assumed that the hemp industry would secure approximately 1% of the total annual investment amount of the above sectors of the economy = €150 million.

The model used to arrive at the figures is a standard economic model, employed by many policymakers and governments. The model has been developed by the IFC (International Finance Corporation) a sister organization for the World Bank and a member of the World Bank Group.

The main variables of consideration were (A) indirect jobs, (B) direct jobs, (C) induced jobs (created by second-order growth effects such as the economy). The estimation, benchmarking and methodology from the meta-evaluation are standard and have been widely implemented in macro-case studies by financial institutions, policymakers, and business leaders.

Direct Jobs = Farmers employed by the agribusiness project
Indirect Jobs = Created by suppliers and distributors
Induced Jobs = Created when overall economic activity rises

Taking several other variables into account and quantifying these models on how to benchmark job creation, we made some conservative projections, and our calculations see that this industry, has the potential to create 82,000 jobs between now and 2027 - that being, if legislative frameworks and state bodies get behind it and support any initiatives that have the potential to drive innovation.

For every €8.9m invested in a sector, there are direct and indirect jobs created; for agriculture, this number will approximate at 200 and 400 jobs respectively.

To create 10,250 direct and indirect jobs annually (induced employment is not included due to the conservative nature of this projection model), the hemp industry would need to attract on average €150 million investment each year (for the span of 8 years, 2019-2027).

The premise for arriving at 10,250 jobs and €150 million annual investment in the hemp industry potential was based on the overall investment in applicable economy sectors in Ireland each year and a very conservative entry level for an industry that ticks the following boxes: sustainability, CO_2 sequestration, high protein food, IP research & development opportunity, export opportunity, global market moods and readiness.

Calc:
82,000 jobs / 8 years = 10,250 jobs annually.
€8.9 million investment = 600 jobs (200+400)
10,250 / 600 = 17
17 * €8.90 million = €151 million

Total investment in agriculture alone in Ireland reached €871 million in 2016.

According to MGC Pharma, Health Europa and Prohibition Partners, the Irish hemp market could potentially reach €2.3b by 2028.

Threats/ Risks

Weather

Results show that cereal production would be affected substantially under the climate change scenario in all regions of the country. Yields are estimated to reduce significantly; yields for winter wheat decreasing up to -11 % in the Southeast region, spring barley yields decreases by up to -10% in both East and Southeast regions. Maize silage however, had a substantial increase in yields in all the regions. The highest increase in the yield (+98%) was projected in the Border region.
We believe increased warmer weather would have a positive effect on the growing of hemp in Ireland but unpredictable weather conditions during setting and harvesting could lead to losses.
https://www.teagasc.ie/media/website/publications/2010/the_impact_of_climate_change_on_irish_farming_5623.pdf

International competition

The Hemp sector is building throughout the world with hemp cultivation increasing in many European countries as well as America and Asia. Due to limited research and innovation in the hemp industry over the last two hundred years, hemp is a relatively untapped industry with many opportunities to replace petroleum-based products and develop new products.

Crop failure / poor germination etc.

Over the past few years there have been instances of poor germination from foreign seeds, resulting in reseeding, poor growth rate and low yields. Research into developing an indigenous seed bank, developed for the Irish climate and future would be a positive step in the security of naturalized species.
The development of a breeding programme for the cultivation of hemp varieties in Ireland could open a large market for Ireland as a distributor of high CBD, feminized hemp seeds into the European Market. The demand for feminized hemp seeds is so high that individual feminized hemp seed with high yielding CBD can be valued at $1 each in the American market. A current 25-kilo bag of hemp seed is worth approximately €400. A 25-kilo bag would include 1.25 million

hemp seeds. If Ireland developed and registered a feminized high yielding CBD strain on the European database of approved seeds, the same 25-kilo bag would now be worth €1.25 million.

Lack of sectoral experience

Longer Licensing Period

The current licensing period for the cultivation of hemp is for 12 months and must be renewed annually. The current licensing duration is a disincentive to farmers and investors who wish to invest in processing and drying equipment.
A 5-year licensing duration with annual notification to the HPRA would provide security for farmers and would incentivise investment. With the projected increase in applications for 2022, a five-year licensing period would also reduce the annual clerical load for the HPRA.

State recognition
Increased recognition from several state bodies is required to enable the development of the Hemp Industry in Ireland.

Efforts to secure financial assistance to date have been futile with Enterprise Ireland advising they cannot engage at present as it is a matter for the Department of Agriculture. Likewise, engagement from LEADER has been minimal during attempted discussions. Recognition and participation is still required from the following bodies:

- Department of Agriculture
- Department of Health
- Coillte
- Enterprise Ireland
- Leader
- Intertrade

APPENDIX - Attached

Please see the various attached documents for citations and references.