HCI's Protein Aid Scheme submission

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MARCH 29

Hemp Cooperative Ireland (HCI)
Authored by: [redacted]

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HEMP COOPERATIVE
IRELAND
EST. 2018

Protein Aid Scheme submission

We would first of all like to state that due to the current grey areas concerning the hemp leaf and flower we encourage all our members to grow hemp primarily as a food and fibre crop.

- The objective of this submission is to propose that hemp should be covered under the CAP Protein Aid Scheme, the GLAS subsidy, 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 or to engage in further conversation with the 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 needs 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 used as a nutritious plant protein in current times where experts say we need to decrease out 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 provide 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 out reliance on pesticides which are continuing to damaging our wildlife, health, crops, soils and rivers.
- Increasing the amount of hemp grown here can help Ireland can become a leader in carbon sequestration as it tackles to meet its 2030 commitments, this will be made all the more easier with a crop like hemp as on average, it sequesters 10 tonnes of CO_2 per ha.
- This submission will explain how an extra incentive like a protein payment, could help to create an indigenous industry while also increasing the ever growing interest in hemp farming.

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- It will also show how growing hemp in Ireland is financially viable based on a case study carried out last year 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.
- I believe, that evidence is provided here to support all of these points.
- There are some interesting case studies that are included at the end along with all references from published papers.

HCI appreciates 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

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About Hemp Cooperative Ireland (HCI)

HCI, as an independent member-owned new cooperative seeks to develop an Irish hemp industry to its best possible potential over a wide range of products; food, building and environmental. HCI is founded on seven pillars, or principles of hemp, namely; personal wellbeing, food and beverage, carbon sequestering, rural regeneration, animal welfare, sustainable circular bio-economy and sustainable construction.

In 2019 it had 170 members, one third of whom were growers and the remaining two thirds were made up of processers and supporters of the emerging new industry.

HCI makes this submission to the Department of Agriculture as we believe that if hemp was to successfully qualify for a protein payment, this would encourage many more farmers to grow the crop and in turn would make it more attractive for people to invest in the industry and for greater markets to be created. This submission will inform some the benefits of hemp growing and how an extra incentive like a protein payment or GLAS subsidy could rejuvenate and/ or create an indigenous industry and also for our country as a whole.

Last year one of our (now) current members independently completed a thesis entitled "Hemp growing as an alternative income for Irish farmers". The following relies on the key findings of this work, of other independent industrial and academic research, of research independently commissioned by HCI, as well as analysis of international trends in the burgeoning industrial hemp sector.

"Only 5% of farmers are under 35 and 30% of farmers are over 65. Therefore, there needs 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)

"It was concluded that currently, hemp growing is indeed feasible and viable in Ireland, due to its low maintenance, soil adaptability, and its agronomic and environmental benefits."

"Hemp growing has the potential to become an alternative source of income for farmers in Ireland. As the industry is in its infancy, it will take time before its full potential is achieved".

Commented [CE1]: Taken from abstract of thesis by [redacted] entitled "Hemp growing as an alternative income for Irish farmers".

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Introduction

This paper is broken into 6 chapters.

- Chapter 1 focuses on hemp and the biodiversity benefits that growing hemp in Ireland can bring.
- Chapter 2 discusses the part that hemp can play in reducing our carbon emissions.
- Chapter 3 focuses on the financial feasibility and viability of growing hemp in Ireland.
- Chapter 4 outlines the nutritional information of hemp and its benefits as food.
- Chapter 5 focuses on some of the different uses for hemp.
- Chapter 6 summarises the conclusion formed, based on the research, and it also outlines the future studies that can be undertaken.

1.1 What is Hemp?

Industrial hemp (Cannabis) is a C3 plant that is classified into the family of Cannabaceae. It is subdivided into three main types such as C. sativa, C. indica, and C. ruderalis. C. sativa is characterized by long, thin flowers and spiky leaves. Industrial hemp has emerged as a potential energy crop along with several advantages. Hemp exhibits many salient features like low feed- stock cost, high biomass content, high land use efficiency, higher dry matter (DM) yield, low nutrients requirement, no/zero pesticide demand and can improve soil health with organic matter. It can be effectively grown in diverse climates and can be used in organic crop rotation. Hemp biomass (HB) produces high biomass as well as hemp oil, therefore, it can be used for the production of bioethanol, biogas, bio hydrogen, solid fuel, and biodiesel (Saif *et al.*, 2013).

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With land being more and more sought after in Ireland partly due to an increase in large dairy herds it does matter if a crop grows more biomass faster now more than ever. According to the CSO's 'Statistical yearbook of Ireland 2019' the number of dairy cows increased by over 27% in the period 2013 to 2018.

Commented [CE3]: https://www.cso.ie/en/releasesandpublications/ep/p-syi/statisticalyearbookofireland2019/agri/cl/

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1.2 Hemps non reliance on pesticides/fungicides/herbicides

Inputs required for cultivation of any crop are an important environmental consideration because of the pollution created in their production and left behind from their use—from the manufacture of chemical fertilizers, herbicides and pesticides, to their shipment, storage, and delivery in the field.

Hemp cultivation requires no fungicides, herbicides or insecticides as it is naturally resistant to fungus, insects and other pests (Crowley, 2001).

Hemp shows environment friendly attributes throughout its life cycle. In a recent study, it was reported that hemp biomass showed the lowest impact on environment in comparison with all biomass, against the parameters such as nutrient depletions, pesticide application, soil compaction and agro-biodiversity (Saif *et al.*, 2013).

Assessments of industrial hemp as compared to hydrocarbon or other traditional industrial feedstocks show that, generally, hemp requires substantially lower energy demands for manufacturing, is often suited to less-toxic means of processing, provides competitive product performance (especially in terms of durability, light weight, and strength), greater recyclability and/or biodegradability, and a number of value-added applications for by-products and waste materials at either end of the product life cycle. Unlike petrochemical feedstocks, industrial hemp production offsets carbon dioxide emissions, helping to close the carbon cycle.(Hayo M. G. van der Werf, 2004).

It is fair to assume that industrial hemp grown intensively (with fertilizer and irrigation) in monoculture over time would eventually develop pests and disease that required treatment. If generalizations from experience with other crops hold true with hemp, the prevalence of harmful pests could be minimized through boosting genetic (Smith-Heisters, 2008).

One study of hemp for the U.S. market suggests that, "an area of land only 25 miles square is sufficient to produce enough hemp fiber in one year to manufacture 100 million pairs of denim jeans, thus providing an equivalent yield to an area ten times the size planted in cotton, and offering the additional benefit of producing clothing which is 10 times stronger than cotton and that, in contrast to cotton which requires exceptionally high applications of pesticides and enormous quantities of water, requires no pesticides and only minimal quantities of water as well (Adams, Richard A, 2000).

Irrigation runoff also carries sediment, pesticides, fertilizer, and other contaminants, contributing to eutrophication and toxicity in nearby waterways.

Commented [CE4]: THE PERFORMANCE OF CANNABIS SATIVA (HEMP) AS A FIBRE SOURCE FOR MEDIUM DENSITY FIBRE BOARD (MDF)

Commented [CE5]: http://dx.doi.org/10.1016/j.rser.2012.10.019

Commented [CE6]: DOI: 10.1016/j.rser.2012.10.019 Illegally Green: Environmental Costs of Hemp Prohibition By Skaidra Smith-Heisters

Commented [CE7]: Environmental costs of hemp prohibition

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1.3 A bee friendly crop

Declining bee numbers are a hot topic in Ireland in recent years 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 time 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 botanical insecticide. The extraction can be performed via steam 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.

The species richness of wild bees and other pollinators has declined over the past 50 years, with some species undergoing major declines and a few going extinct. Managed honey bee stocks have also declined in North America and many European countries, although they have increased substantially in China. During this same period, the demand for insect pollination of crops has approximately tripled, and the importance of wild pollinators in providing such services has become increasingly apparent, leading to concern that we may be nearing a "pollination crisis" in which crop yields begin to fall.

If pollination fails, ecosystems are eroded and we will lose reliable sources of many critical foodstuffs. Focusing on the pollination services provided by bees, Goulson *et al.* reviewed the stresses bees are experiencing from climate change, infectious diseases, and insecticides. We can mitigate some of the stress on bees by improving floral resources and adopting quarantine measures, and by surveillance of

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bee populations. Crucially, we need to resolve the controversy surrounding prophylactic use of pesticides.

Bees are subject to numerous pressures in the modern world. The abundance and diversity of flowers has declined; bees are chronically exposed to cocktails of agrochemicals, and they are simultaneously exposed to novel parasites accidentally spread by humans. Climate change is likely to exacerbate these problems in the future. Stressors do not act in isolation; for example, pesticide exposure can impair both detoxification mechanisms and immune responses, rendering bees more susceptible to parasites. It seems certain that chronic exposure to multiple interacting stressors is driving honey bee colony losses and declines of wild pollinators, but such interactions are not addressed by current regulatory procedures, and studying these interactions experimentally poses a major challenge. In the meantime, taking steps to reduce stress on bees would seem prudent; incorporating flower-rich habitat into farmland, reducing pesticide use through adopting more sustainable farming methods, and enforcing effective quarantine measures on bee movements are all practical measures that should be adopted. Effective monitoring of wild pollinator populations is urgently needed to inform management strategies into the future.

1.4 Soil Benefits of growing hemp

Hemp is a rapidly growing plant which 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 metre in depth for fibre crops and around 10 inches in duel crops, 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).

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1.5 Hemp as a break crop

Hemp is an excellent break crop as its extensive root system improves soil structure (Finnan and Burke, 2013a). Subsequent crops have less weed pressure, and yield increases of 10%–20% have been demonstrated in winter wheat crops grown after hemp (Bosca & Karus, 1997). In addition, the fact that hemp is an annual crop offers farmers the opportunity to investigate the energy market without committing their land for up to 20 years if suitable markets exist. Apart from diesel and seed, the only input required for the cultivation of hemp is fertilizer, as the crop is typically grown without inputs of herbicide, insecticide and fungicide (Crowley, 2001).

Previous experience has led to the conclusion that fungicides are not beneficial and are not recommended (Van der Werf et al., 1995a; ITC, 2007). The most important nutrients required for all crops are nitrogen, phosphorus and potassium. However, the most costly of these nutrients, in both economic and environmental terms, is nitrogen and crops are generally more responsive to nitrogen than to phosphorus or potassium (Hay & Walker, 1989).

2.1 Hemp can help reduce GHGs

Global warming has been found to be associated with increased concentrations of atmospheric greenhouse gases such as carbon dioxide (C02). CO2 emitted from the burning of fossil fuels is not absorbed by the vegetation cover and thus causes the global temperature to rise by continuing to remain in the atmosphere. Industrial hemp uses solar energy to convert atmospheric CO2 to hydrocarbons and water. In addition, O2 is produced. This absorptive CO2 is released back into the atmosphere only when the hemp is composted or burned. Hemp provides the protection of forests in the production of energy and paper. The high amount of O2 released to the atmosphere is due to the rapid growth of the hemp plant. Hemp can be processed into building materials. Thus, even though traditional construction has a high carbon footprint, hemp can be used to build 'zero carbon' structures, i.e. building materials absorb more CO2 than is produced during construction.(Aytaç, 2018)

Commented [CE8]: https://www.researchgate.net/publication/329328155_An_Environmentally_Friendly_Plant_in_Terms_of_Oxygen_Supply_Hemp

Carbon dioxide (CO2), methane (CH4) and nitrogen (N2O) are considered the major inputs and sinks of greenhouse gases (GHGs) (Finnan and Burke, 2013a). 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

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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 CO2 per ha. This in turn can aid the Irish agriculture sector to meet its stringent targets (Finnan and Styles, 2013b).

2.2 Hemp as an energy crop

Commented [CE9]: Taken from The science behind hemp as a carbon sink (Vosper, 2011)

Hemp's rapid growth (grows to 4 metres in 100 days) makes it one of the fastest CO2-to-biomass conversion tools available, more efficient than agro-forestry. Biomass is produced by the photosynthetic conversion of atmospheric carbon. The carbon uptake of hemp can be accurately validated annually by calculations derived from dry weight yield. This yield is checked at the weighbridge for commercial reasons prior to processing.

Highly accurate figures for total biomass yield and carbon uptake can then be made, giving a level of certainty not available through any other natural carbon absorption process.

The following carbon uptake estimates are calculated by the examining the carbon content of the molecules that make up the fibres of the hemp stem. Industrial hemp stem consists primarily of Cellulose, Hemicellulose and Lignin, whose chemical structure, carbon content, (and therefore absorbed CO2).

Cellulose is 70% of stem dry weight. Cellulose is a homogeneous linear polymer constructed of repeating glucose units. The carbon content of cellulose accounts for 45% of its molecular mass.

Hemicellulose is 22% of stem dry weight. Hemicellulose provides a linkage between cellulose & lignin. It has a branched structure consisting of various pentose sugars.

Lignin is 6% of stem dry weight. Lignin is a strengthening material usually located between the cellulose microfibrils. The lignin molecule has a complex structure that is probably always variable.

To summarise the above, one tonne of harvested stem contains:

0.7 tonnes of cellulose (45% Carbon)

0.22 tonnes of hemicellulose (48% Carbon

0.06 tonnes of lignin (40% Carbon)

It follows that every tonne of industrial hemp stems contains 0.445 tonnes Carbon absorbed from the atmosphere (44.46% of stem dry weight).

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Converting Carbon to CO2 (12T of C equals 44T of CO2(IPCC)), that represents 1.63 tonnes of CO2 absorption per tonne of UK Hemp stem harvested. On a land use basis, using Hempcore's yield averages (5.5 to 8 T/ha), this represents 8.9 to 13.4 tonnes of CO2 absorption per hectare of UK Hemp Cultivation.

Hempcore are the UK's largest grower and processor of hemp, they contract around 3000 ha of hemp from UK farmers and they manufacture fibre and animal bedding.

For the purposes estimation, we use an average figure of 10T/ha of CO2 absorption, a figure we hold to be a reasonably conservative estimate. This is used to predict carbon yields, but CO2 offsets will be based on dry weight yields as measured at the weighbridge.

A recent study reveals that hemp biomass can save 70–255 GJ/ha of energy along with a greenhouse gas saving of 9–28 t CO2-eq/ ha in comparison with coal or natural gas) for fuel(Cherubini *et al.*, 2009)

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 over reliance 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).

Because hemp has a number of qualities that make it superior to wood for the production of paper, the pulping is more efficient both environmentally and economically (Smith-Heisters, 2008).

Studies performed over 3 years (1997-1999) by Teagasc showed that hemp yields increased up to an application rate of 120kg N/ha (96 units/ac) but there was no benefit in yield when nitrogen was increased beyond this. This result was obtained at all sites across all years irrespective of soil type, soil nitrogen level or previous cropping history (Crowley, 2001).

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).

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2.3 Hemp: A more sustainable annual energy crop for climate and energy policy

(Finnan and Styles, 2013b)

A paper produced in 2013 by Finnan and Styles stated that hemp is a considerably more efficient bioenergy feedstock than the dominant annual energy crops, which are miscanthus and willow, and two more traditional annual bioenergy crops, sugar beet and oil seed rape (OSR). Integrated into food crop rotations, hemp need not compete with food supplies, and could provide an appealing option to develop more sustainable non-transport bioenergy supply chains.

Hemp is more appealing to risk averse farmers for whom a higher discount rate should be considered. With an annual energy crop such as hemp, farmers receive full returns in the year of planting, and are free to continue or discontinue with hemp cultivation the following year based on experience. By contrast, a decision to grow perennial energy crops is accompanied by a high initial investment, a waiting period before cash flows become positive, and a commitment of land for a period of 20+ years.

Hemp may be a particularly valuable crop to introduce farmers to bioenergy production and to establish biomass supplies. The shrinkage of the EU sugar sector since 2006 has meant that a lot of tillage land in Europe is without an efficient break crop. Hemp offers a far more efficient alternative to sugar beet and OSR, as a break crop that can be used for bioenergy production and greenhouse gas mitigation.

The net GHG abatement attributable to the hemp energy chain under the mid yield estimate, 11 t/CO2eq./ ha/year, is 140% greater than for OSR energy chains and 540% greater than for the sugar beet ethanol fuel chain, expressed per hectare of land planted. Net GHG abatement attributable to the hemp energy chain is slightly lower than for the Miscanthus and SRC energy chains when the latter crops are planted on arable land, but higher than for Miscanthus and SRC energy chains when those crops are planted on grassland (Finnan and Styles, 2013a).

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3.1 Research methodology

In this case study, the cost of hemp growing and harvesting was compared with Ireland's 3 main cereal crops; wheat, barley and oats. This was to be performed by using figures for hemp growing and comparing them with the 2019 Crops Costs and Returns booklet which was published by Teagasc. The hemp growing figures were to be obtained from the hemp growing farmers and experts in the industry. The comparison would be performed using figures obtained from the Finola variety as it is a dual crop and can be used for the seed and the fibre. Dual purpose varieties of hemp were reported to have yields of 5 tonne per hectare for the fibre portion and 1.25 tonnes per hectare of seed.

It was decided not to include the flower and leaf section of the plant in this comparison as there discrepancies surrounding the use of these parts of the plant and it requires more research also.

The aim of this study was to interview 7 participants which was 10.6% of all hemp grower in Ireland in 2019. The main pre requirement for involvement in this study was that each participant had to have experience in the growing and cultivation of hemp. 7 hemp growing farmers from different parts of Ireland were chosen to be interviewed.

3.2 Financially viable crop

GROSS MARGINS for Organic Hemp (seed and fibre only) (Incl. Straw)

Expected Margin	Feed Wheat		Feed Barley		Feed oats		
	Winter	Spring	Winter	Spring	Winter	Spring	Hemp
€/ac	296	227	255	200	222	150	413
€/ha	753	578	649	509	566	384	1020

Gross margin comparison between cereals and hemp (Carew, 2019).

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

All costs for hemp were obtained from the feedback of the 7 participants and then a Mean was calculated.

As seen in the above table, hemp has a gross margin of €413/ac or €1020/ha respectively. The next best crop is winter wheat which has €296/ac or €753/ha which is a difference of €117/ac or €267/ha in comparison with organic hemp growing. Therefore it can be concluded that growing organic hemp has a 39.5% higher gross margin return in comparison with its nearest cereal crop competitor(Carew, 2019).

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4.1 Nutritional information

Hempseed oil is over 80% in polyunsaturated fatty acids (PUFAs), and is an exceptionally rich source of the two essential fatty acids (EFAs) linoleic acid (18:2 omega-6) and alpha-linolenic acid (18:3 omega-3). The omega-6 to omega-3 ratio (n6/n3) in hempseed oil is normally between 2:1 and 3:1, which is considered to be optimal for human health. In addition, the biological metabolites of the two EFAs, gamma-linolenic acid (18:3 omega-6; 'GLA') and stearidonic acid (18:4 omega-3; 'SDA'), are also present in hempseed oil. The two main proteins in hempseed are edestin and albumin. Both of these high-quality storage proteins are easily digested and contain nutritionally significant amounts of all essential amino acids. In addition, hempseed has exceptionally high levels of the amino acid arginine. Hempseed has been used to treat various disorders for thousands of years in traditional oriental medicine. Recent clinical trials have identified hempseed oil as a functional food, and animal feeding studies demonstrate the long-standing utility of hempseed as an important food resource(Callaway, 2004). Western diets are currently thought to have a ratio of 15/1 – 16.7-1 of omega 6 and omega 3. This has been linked with the promotion of many disease states including cancer, cardiovascular disease, inflammatory and autoimmune diseases. Therefore, lowering the omega 6 and omega 3 ratio in diets can exert suppressive effects (Simopoulos A P, 2002). Studies on rats suffering from kidney disease have shown that by adding hemp seed protein into their diet, it has reduced the severity of the disease and has improved the associated cardiovascular injury outcome (Malomo and Aluko, 2015).

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Table 1. Typical nutritional content (%) of hempseed[a]

	Whole seed	Seed meal
Oil (%)	35.5	11.1
Protein	24.8	33.5
Carbohydrates	27.6	42.6
Moisture	6.5	5.6
Ash	5.6	7.2
Energy (kJ/100 g)	2200	1700
Total dietary fiber (%)	27.6	42.6
Digestable fiber	5.4	16.4
Non-digestable fiber	22.2	26.2

[a]cv Finola.

(Callaway, 2004)

The projected world population for 2050 is just under 10 billion which would make animal protein sources unsustainable as the costs to raise the animals for this protein demand would be too high (Luna, 2017). This fact coupled with specialists advising consumers to halve their red meat daily intake to 14g per day and to increase their plant protein intake certainly doesn't do the beef farmer any favours (Willett *et al.*, 2019). This means that hemp can help fill the gap for ever increasing demand for plant based protein.

The Department of Agriculture stated in 2014 that Ireland's and the EU's dependence on imported protein sources such as soya bean meal (SBM) has initiated a legislative and political push towards the development of indigenous plant–based protein sources(Brennan *et al.*, 2014). There is a great opportunity to use hemp to improve this situation.

Table 2. Typical fatty acid profiles (%) of hemp and other seed oils

Seed	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	AL[b] acid	GLA	SDA	%PUFA	n6/n3 ratio
Oil hempseed[a]	5	2	9	56	22	4	2	84	2.5
Fiber hempseed	8	3	11	55	21	1	<1	77	2.7
Black currant	7	1	11	48	13	17	3	81	4.1
Flax (linseed)	6	3	15	15	61	0	0	76	0.2
Evening primrose	6	1	8	76	0	9	0	85	>100.0
Sunflower	5	11	22	63	<1	0	0	63	>100.0
Wheat germ	3	17	24	46	5	5	<1	56	10.2
Rape seed	4	<1	60	23	13	0	0	36	1.8
Soy	10	4	23	55	8	0	0	63	6.9
Borrage	12	5	17	42	0	24	0	66	>100.0
Corn	12	2	25	60	1	0	0	60	60.0
Olive	15	0	76	8	<1	0	0	8	>100.0

[a]cv. Finola.
[b]AL: *alpha*-Linolenic acid.

(Callaway, 2004)

The absence of antinutritional factors in Hemp Protein Isolate (HPI) is a major advantage for use in the food industry, along with the presence of bioactive compounds. Just like soy protein isolate, HPI may find a range of uses in the food industry. These uses could range from ingredients in meat free alternatives, non-conventional gluten free dough to edible films (Mamone et al., 2019).

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Table 4. Typical nutritional values (mg/100 g)for vitamins and minerals in hempseed[a]

Vitamin E	90.0
Thiamine (B1)	0.4
Riboflavin (B2)	0.1
Phosphorous (P)	1160
Potassium (K)	859
Magnesium (Mg)	483
Calcium (Ca)	145
Iron (Fe)	14
Sodium (Na)	12
Manganese (Mn)	7
Zinc (Zn)	7
Copper (Cu)	2

[a]cv Finola.

(Callaway, 2004)

Table 3. Typical protein content (%) of each food is given directly below the name

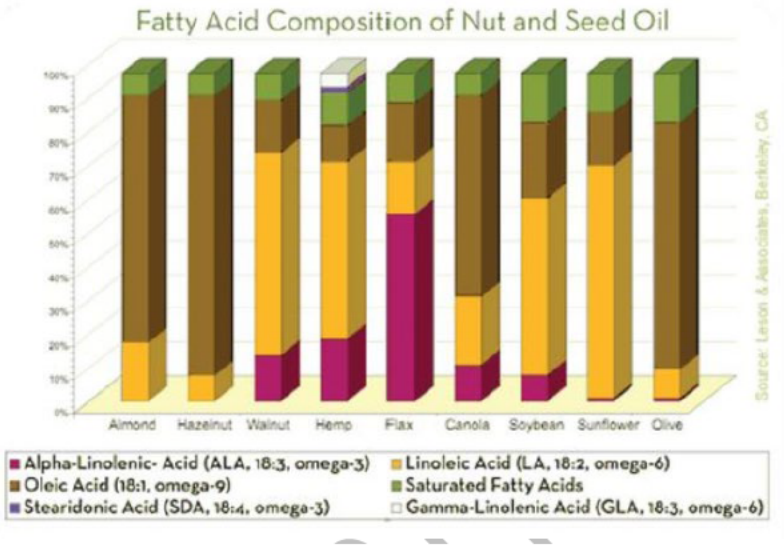
Amino acid	Potato (2%)	Wheat (14%)	Maize (11%)	Rice (9%)	Soy bean (32%)	Hempseed (25%)	Rapeseed (23%)	Egg white (13%)	Whey powder (13%)
Alanine	0.09	0.50	0.72	0.56	1.39	1.28	1.05	0.83	0.61
Arginine	0.10	0.61	0.40	0.62	2.14	3.10	1.49	0.68	0.39
Aspartic acid	0.34	0.69	0.60	0.86	3.62	2.78	1.82	1.23	1.49
Cystine	0.02	0.28	0.15	0.10	0.54	0.41	0.39	0.29	0.17
Glutamic acid	0.37	4.00	1.80	1.68	5.89	4.57	4.41	1.67	2.40
Glycine	0.10	0.71	0.35	0.47	1.29	1.14	1.28	0.50	0.29
Histidine*	0.03	0.27	0.26	0.19	0.76	0.71	0.72	0.28	0.29
Isoleucine*	0.08	0.53	0.35	0.35	1.62	0.98	1.00	0.74	0.85
Leucine*	0.11	0.90	1.19	0.71	2.58	1.72	1.80	1.08	1.40
Lysine*	0.10	0.37	0.33	0.31	1.73	1.03	1.49	0.74	1.15
Methionine*	0.02	0.22	0.18	0.17	0.53	0.58	0.46	0.47	0.23
Phenylalanine*	0.08	0.63	0.46	0.43	1.78	1.17	1.05	0.76	0.49
Proline	0.09	1.53	0.85	0.40	1.65	1.15	1.59	0.50	0.43
Serine	0.08	0.70	0.47	0.48	1.54	1.27	1.10	0.92	0.64
Threonine*	0.07	0.42	0.34	0.34	1.35	0.88	1.13	0.58	1.02
Tryptophan*	0.02	0.51	0.04	0.09	0.41	0.20	0.31	0.20	0.25
Tyrosine	0.06	0.40	0.36	0.33	1.14	0.86	0.69	0.46	0.47
Valine*	0.10	0.61	0.46	0.51	1.60	1.28	1.26	0.98	0.91

Individual amino acid values for each food is given in grams per 100 g. Essential amino acids are indicated by an asterisk (*).

(Callaway, 2004)

Hemp seed consumption would be an ideal way for someone who is vegan to get all the essential amino acids in their diet as seen above.

Commented [CE10]: https://www.feednavigator.com/Article/2020/04/21/US-group-to-seek-approval-of-hemp-seed-meal-for-chickens



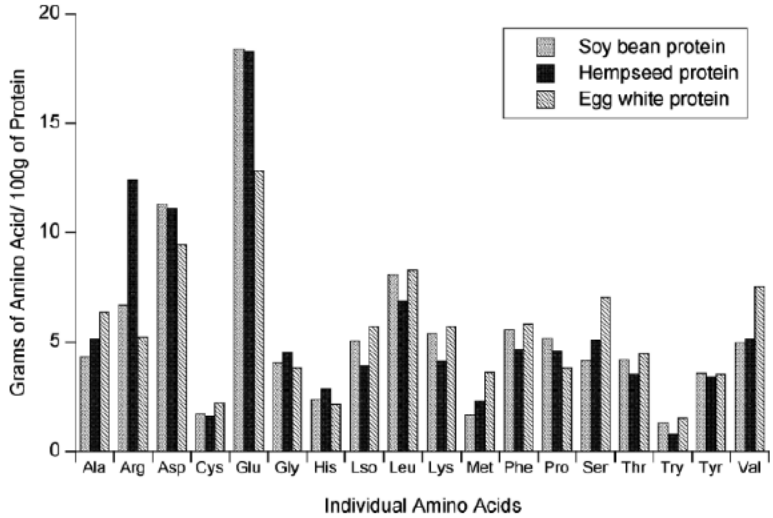


Figure 1. Graphical representation of protein amino acid profiles for soy bean, hempseed (cv Finola) and egg white. Individual amino acids are represented by their IUPAC abbreviations.

(Callaway, 2004)

Hempseed is an excellent source of nutrition. Indications from traditional Chinese medicine, recent anecdotal reports and modern human clinical trials agree that hempseed has health promoting properties that are supported by results from nutritional analyses of the seed, oil and seed meal. In particular, the healing properties of hempseed can be attributed to high levels of EFAs and other PUFAs in the oil, in addition to a rich source of important amino acids in an easily digested protein. Recent feeding trials with fish, hens and ruminants, in addition to empirical observations over thousands of years, have effectively demonstrated that hempseed and its derivatives are useful in animal feed as well. Subjective concerns over THC in hemp foods are not supported by scientific evidence (Callaway, 2004).

4.2 An easily digested product

An alternative which is generating interest is the use of hemp as an energy crop. It has already been demonstrated that hemp is a suitable feed- stock for anaerobic digestion as well as for combustion (Kreuger *et al.*, 2011)(Finnan and Burke, 2013a).

Hemp-based food products are considered less allergenic than those from other edible seeds, although this statement had never been experimentally verified. In a study carried out by (Mamone *et al.*, 2019), high purity grade hemp flour (HF) and hemp protein isolate (HPI) were obtained through a fast and cheap process starting from defatted hemp cakes, a residue of hempseed oil extraction. HPI resulted enriched at nearly 86% protein, mainly constituted by the storage protein edestin (accounting for 70% total protein). In vitro protein digestibility was determined using a static model of gastrointestinal digestion (GID), which included a final step with purified brush border membrane (BBM) enzyme preparations. HF and HPI showed a high degree of digestibility. The survival of potential bioactive and/or allergenic peptide sequences in digests was investigated by peptidomic analysis. Only a limited number of sequences survived GID. Among them, fragments from 12 seed proteins. These fragments were precursors of sequences with potential bioactive peptides, which might justify the bioactivity of HPI hydrolysates, reported in previous studies. More importantly, all known hemp allergens, including the major thaumatin-like protein and LTP, were entirely eliminated by the HPI production process, neither fragments of the proteins were present after GID. These data support the use of HPI as an ingredient for hypoallergenic foods(Mamone *et al.*, 2019).

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In another study carried out by Hessle *et al.*, 2008, cold-pressed hempseed cake was investigated as a protein feed for young calves and finishing steers. Half of the animals were fed cold-pressed hempseed cake, whereas the other half were fed a mixture of soybean meal and barley. Effects on feed intake, live weight gain (LWG), faecal traits and carcass traits (steers only) were studied. Neutral detergent fibre intake was higher for animals fed hempseed cake than for those fed soybean meal (PB0.05). In addition, the number of long particles in faeces was lower (PB0.05) and faecal dry matter content and consistency were higher from animals which were fed hempseed cake (PB0.05; steers only). Higher feed intakes in calves fed hempseed cake (PB0.05) combined with similar LWG resulted in lower feed efficiency in hemp-fed calves (PB0.05).

In conclusion, cold-pressed hempseed cake as a protein feed for growing cattle compared to soybean meal results in similar weight gains and carcass traits and, due to a higher fibre content and/or a lower starch content, leading to an improved rumen function. Therefore hempseed cake compared to soybean meal as a protein feed for intensively fed growing cattle results in similar production and improved rumen function(Hessle *et al.*, 2008).

Also in an article in the Irish Examiner in 2018, secretary of the Irish Pig Health Society Shane McAuliffe, from McAuliffe Pig Farms in Co Kerry, stated that he has worked with nutritionists from Cargill to reduce the amount of soya protein in his pigs' diets by 20%, subsequently reducing his pigs' ammonia emissions by 15%.

Commented [CE11]: https://www.irishexaminer.com/breakingnews/farming/we-depend-two-times-more-on-imported-animal-feed-than-our-neighbours-832683.html#:~:text=The%20main%20commodities%20imported%20are,and%20GM%20maize%20by%2Dproducts.

4.3 Roughage for dairy cattle

Commented [CE12]: Taken from http://pantanova.nl/diervoeder (Case study carried out in Gelderland) Roughage for dairy cattle

In recent years, a growing number of dairy farmers have gained experience with fiber hemp in the rations of their cows and goats. They are enthusiastic about the effects of hemp on their animals. The advantages seem to lie primarily in a better conversion of the feed in combination with a higher activity and better milk production.

Dairy cows and goats need 'prick' and the formation of a 'mat' in their rumen for optimal digestion. Because hemp combines special ingredients with a high percentage of cell parts that are difficult or not digestible, this crop cultivation offers an interesting source of structure from the existing perspective on roughage. Hemp also contains protein that is digestible for animals and humans. Dairy cattle require both structure feed and protein.

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Nutritional: The nutritional value of fiber hemp is lower than that of conventional roughage. According to experts, adding to the feed mix nevertheless leads to added value that other ingredients provide less or not. Dairy farmers surveyed, for example, point to a lower use of antibiotics and that their animals develop less inflammation of the udders and claws.

Findings: Practical research by HAS Den Bosch showed in 2014 that less than 1 percent of all approximately 17,000 dairy farms in the Netherlands have gained experience with fiber hemp. Given the positive findings of the more than eighty livestock farmers surveyed, it appears that a market is open for roughage hemp. The HAS study shows that hemp can be regarded as a cheap regional alternative for (import) alfalfa and grass seed hay, among others.

Animal health: On the other hand, it is clear that hardly any scientific knowledge, facts and long-term experiences have been documented to substantiate the claimed effects of roughage hemp. This can be done by examining the effects on health aspects and assessing the effect on the operating result. Additional (practical) research will have to be carried out for a wider application of roughage hemp.

Production: The production of roughage hemp is very similar to that of silage maize, but requires considerably less labor, less crop protection, less or no fertilizer and little water. The harvest takes place in the calm before the storm, which reigns every year as soon as the harvest time for maize and beet arrives. The latter aspect of hemp cultivation is also interesting for contracting companies. If the feed is ensiled, no further processing is required after harvest, other than ensiling itself.

Perspective: In 2014 and 2015, the production of roughage hemp started on a modest scale in Gelderland. The first results are encouraging. In the region, the crop thrives on clay soil. Cows, goats and livestock farmers are enthusiastic. In 2016, the area of roughage hemp in Gelderland was expanded to approximately 25 hectares. The decisive factor for the increase in scale will be that fiber hemp offers a sustainable perspective as a profitable rotational crop in the business operations of arable farmers.

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4.4 Articles concerning hemp as a feed for animals

Other Agricultural Uses for Industrial Hemp;
https://hempgazette.com/industrial-hemp/agricultural-uses-hemp/

Cold-pressed hempseed cake as a protein feed for growing cattle;
https://www.tandfonline.com/doi/full/10.1080/09064700802452192?src=recsys

Hemp may reduce diarrhea and mortality of young pigs;
https://anis.au.dk/en/current-news/news/show/artikel/hamp-til-kamp-mod-diarre-og-pattegrisedoedelighed/

More Dutch cows eat hemp;
https://dutchdailynews.com/cows-eat-hemp/

Colorado's Hemp Animal Feed Bill Clears House Of Representatives;
https://hempgazette.com/news/hemp-animal-feed-hg0346/

Hemp is the not-so-secret ingredient in farmer's cow feed;
http://www.globalhemp.com/2004/05/hemp-is-the-not-so-secret-ingredient-in-farmers-cow-feed.html

The effect of feeding hemp seed meal to laying hens;
https://www.tandfonline.com/doi/full/10.1080/00716605000661837scroll=top&needAccess=true

Effects of heat-treated hempseed supplementation on performance, egg quality, sensory evaluation and antioxidant activity of laying hens;
https://www.tandfonline.com/doi/full/10.1080/00071668.2018.1547360?src=recsys

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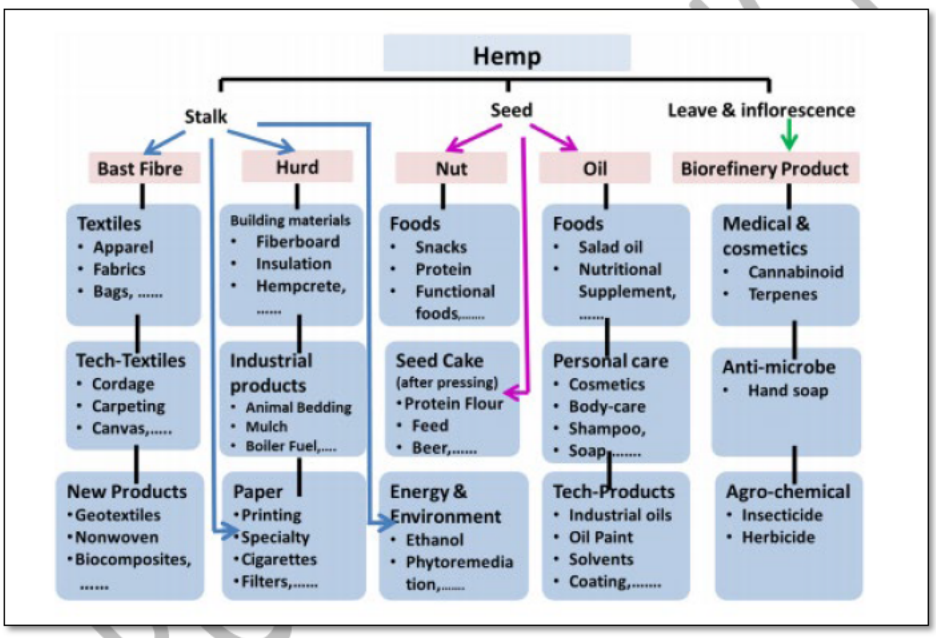
5.1 Other uses for hemp

Hemp is a multi-purpose crop, which can be used for the stalk, the seeds, the flower and leaf and the root (Carus, 2017). In fact, hemp products are associated with over 50,000 different product applications across multiple industries (Caslin, 2007). **Error! Reference source not found.** outlines some modern uses of the stalk, seed and leaves of the hemp crop.

Commented [RJ13]: Just this



Flowchart of multi-purpose hemp utilisation.
Source: New developments in fibre hemp (Cannabis sativa L.) breeding, Industrial Crops and Products; Industrial Crops and Products,Volume 68,2015,Pages 32-41,ISSN 0926-6690

There is a market in Ireland for hemp but most of it is being imported unfortunately.

We will speak to the large companies who are already heavily invested in hemp as part of their supply chains to determine their interest in purchasing sustainably produced Irish hemp products.

Keadeen Mountain Farms in Wicklow and Cannabaoil in Clare are examples of company's setup by 2 of our members so far.

Other examples of retail companies that use hemp so far to name a few are;

- Musgraves (Supervalu sell hemp milk, hemp seeds so why not use Irish produce)
- Holland and Barrett (CBD/ hemp seeds/protein)
- Health shops (CBD/ hemp seeds/protein)
- Lidl (have hemp seeds in their seed mix bags)
- Jump juices (they use hemp protein in their smoothies)

These companies are only food examples whereas hemp is being used in the construction industry for; insulation, hemp shiv, fibre etc as well.

Hemp products have become increasingly popular throughout Europe, these include; paper, building materials, clothes and CBD (Cannabidiol) oil. There are modern varieties of hemp developed that can be grown for dual purpose use (fibre and seed) (Johnson, 2014). The plant can provide raw material for many end users and supply several income streams for the farmer depending on the harvesting method employed.

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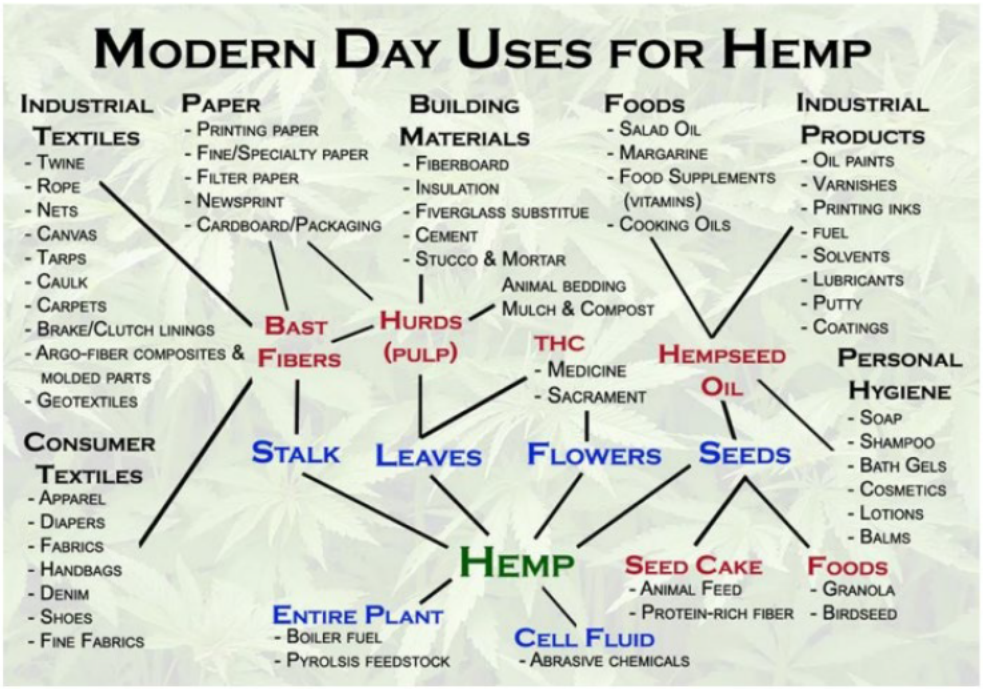

Figure 1. Uses of Hemp [1]

(Aytaç, 2018)

5.2 Import figures

country	(All)									
	year	flow	Values							
	Jan-Dec 2017				Jan-Dec 2018				Jan-Dec 2019	
	Exports		Imports		Exports		Imports		Imports	
SITC	€000	Tonnes	€000	Tonnes	€000	Tonnes	€000	Tonnes	€000	Tonnes
26521									7	1
26529			0	0			3	0	10	0
26580	0	0	59	62	5	5	56	76	591	1,776
Grand Total	0	0	59	62	5	5	59	76	608	1,777

26521	True hemp, raw or retted
26529	True hemp o/t in 265.21
26580	Coconut, abaca (Manila hemp or Musa textilis Nee), ramie and other vegetable textile fibres, n.e.s., raw or processed but not spun; tow, noils and waste of these fibres (including yarn waste

We can see from the figures above that there is a potential to supply 1,777 tonnes of hemp to customers in this country to avoid importing.

Commented [CE14]: https://www.researchgate.net/publication/329328155_An_Environmentally_Friendly_Plant_in_Terms_of_Oxygen_Supply_Hemp

We cannot be sure what % of the SITC code 26580 is made up of hemp though unfortunately as there is no further break down.
Also some countries count hemp seed under (other seeds) and oil under (other oils) so it's unclear if either is included in the above figures.

6.1 Conclusion

It is our view that the cultivation of hemp in Ireland is vital in our battle to reduce pollution, conserve our bee wildlife and to improve soil quality.
Hemp is unmatched as a means of sequestering Carbon Dioxide and binding it permanently in the materials it is manufactured into. The accreditation of hemp as a generator of carbon credits will make its cultivation more attractive.
In addition, the fibre is robust and has a large variety of uses as paper, textile and as a biofuel. The seeds are a valuable source of protein for humans and for use in animal feed. This will stimulate a whole new industry and reduce reliance on imported goods.
The widespread cultivation of industrial hemp in Ireland will give a much needed economic and sustainable boost to remote country areas and areas suffering high unemployment and hardship.

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Please contact me at [redacted] with any further queries.

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