Irish Hemp Event 2022 – Breaking Barriers

A Systems Thinking Approach Investigating the Estimated Environmental and Economic Benefits and Limitations of Industrial Hemp Cultivation in Ireland from 2017–2021

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Problem Statement

There is little research on the environmental and economic benefits of industrial hemp for CO_2 sequestration.

There may be unrecognised environmental and economic benefits in cultivating industrial hemp for CO_2 sequestration in Ireland.

Aims

The current Programme for Government (PFG) commits to exploring the potential for growing fibre crops, including hemp, to see if the crop has a viable market [25].

Based on these policy objectives

The study aimed to answer how industrial hemp has been helpful to carbon sequestration efforts in Ireland, which has a problem with rising CO_2 emissions from agriculture and international financial, legal obligations and environmental policies to maintain.

Hypothesis

If industrial hemp can sequester CO_2 at a rate of up to 22 Mt [16] per hectare

The current carbon tax is at a rate of €33.50 [26]

There may be unrecognised environmental and economic benefits in cultivating hemp for CO_2 sequestration in Ireland.

Research Design

By using a Systems Thinking approach, the study aimed to answer how industrial hemp, which can sequester between 10 to 22 million Mt CO2 per hectare, has been helpful towards carbon sequestration efforts in Ireland.

A mixed-methods design combining qualitative and quantitative secondary material were used to inform Behaviour over Time Graphs (BoTGs) to illustrate the data from 2017 to 2021.

Data Collection and Analysis

Low scenario under estimation: 1 hectare of hemp on average sequesters on average 10 tonnes of net CO_2 per hectare [19,38].

Mid scenario mid estimation: 1 hectare of industrial hemp can absorb on average 15 tonnes of CO_2 per hectare [39,40].

High scenario high estimation: 1 hectare of industrial hemp absorbs an average 22 tonnes of CO_2 per hectare [16–19,22].

Data Collection and Analysis

The unit of analysis is the number of hemp licences issued annually in Ireland and the number of hectares of land cultivating hemp in Ireland since 2016.

The data relating to licensing for this study was obtained from the HPRA in early 2021 and again in late 2021 and relates from the years 2016 to 2021.

There was no data available for the number of hectares cultivated for 2016.

Data Collection and Analysis

- 2021: 76 licences not more than 251 hectares
- 2020: 94 licences not more than 362 hectares
- 2019: 74 licences not more than 547 hectares
- 2018: 24 licences not more than 230 hectares
- 2017: 16 licences not more than 76 hectares
- 2016: 7 licences & no data regarding hectares

Results

Number of Licences Issued and Hectares Cultivated with Industrial Hemp in Ireland 2016-2021
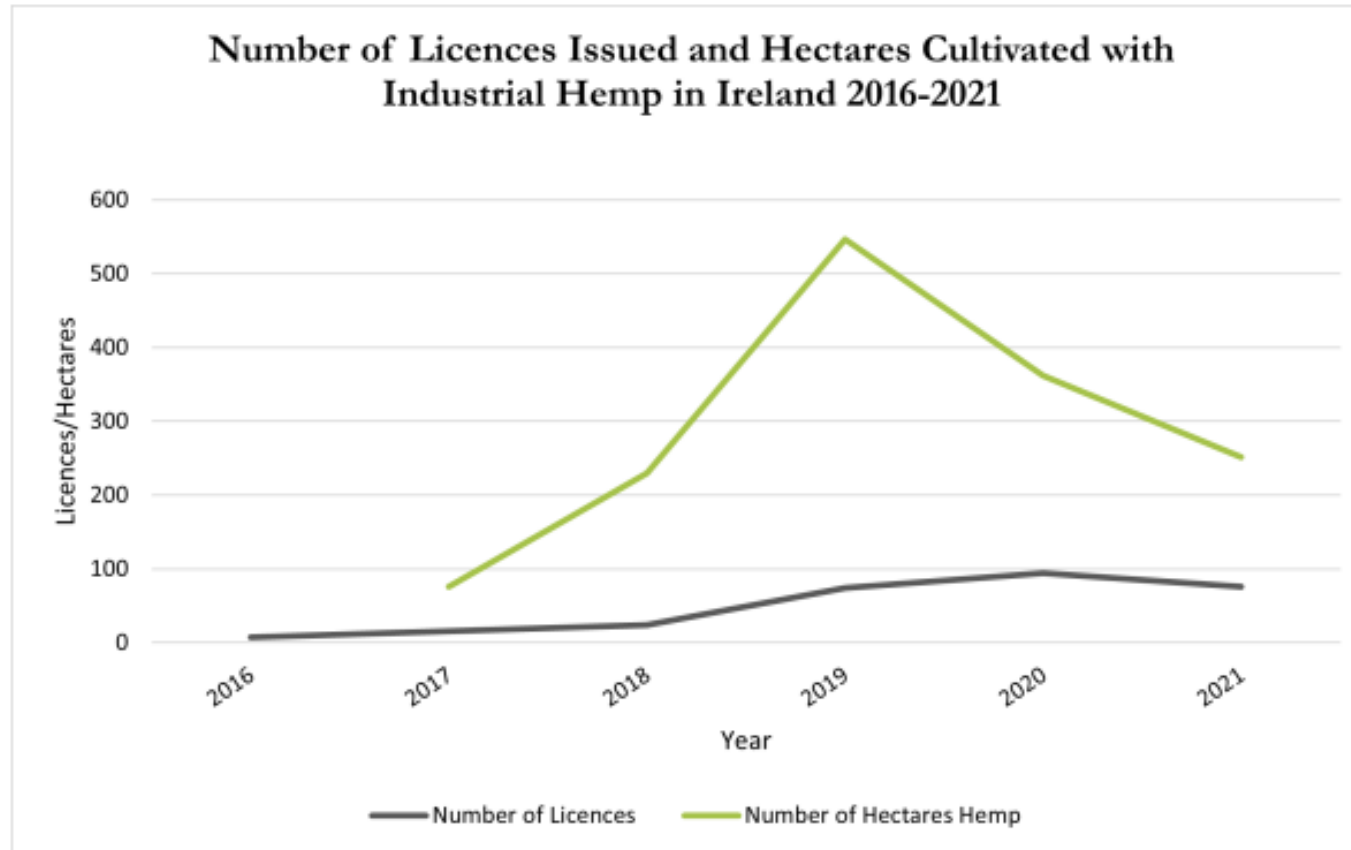
Results

The total land use of industrial hemp cultivation in Ireland at its peak in 2019 represented 547 hectares or 0.0079% of total land use and 0.0123% of agricultural land use

Land Use	Hectares Ha	Percentage %
Total Land	6,900,000	100
Agriculture	4,440,000	64
Forestry	770,020	11
Unsuitable for Agri	1,689,980	25
Industrial Hemp	547	0.0079

Results

The total CO2 emissions from agriculture in 2019 was 21,151.24 million Mt

Potential environmental contribution of industrial hemp cultivation in Ireland from 2017 to 2021 in terms of carbon emissions (millions Mt)

Year	Land Use Ha	Sgl Crop 10 Mt CO_2	Dbl Crop 10 Mt CO_2	Sgl Crop 15 Mt CO_2	Dbl Crop 15 Mt CO_2	Sgl Crop 22 Mt CO_2	Dbl Crop 22 Mt CO_2
2016	-	-	-	-	-	-	-
2017	76	760	1520	1140	2280	1672	3344
2018	230	2300	4600	3450	6900	5060	10,120
2019	547	5470	10,940	8205	16,410	12,034	24,068
2020	362	3620	7240	5430	10,860	7964	15,928
2021	251	2510	5020	3765	7530	5522	11,044
Contribution		14,660 Mt	29,320 Mt	21,990 Mt	43,980 Mt	32,252 Mt	64,504 Mt

Results

Potential economic contribution of industrial hemp cultivation in Ireland from 2017 to 2021 in terms of carbon tax (Euros)

Year	Land Use Ha	Carbon Tax €	Sgl Crop 10 Mt €	Dbl Crop 10 Mt €	Sgl Crop 15 Mt €	Dbl Crop 15 Mt €	Sgl Crop 22 Mt €	Dbl Crop 22 Mt €
2016	-	-	-	-	-	-	-	-
2017	76	20	15,200	30,400	22,800	45,600	33,440	66,880
2018	230	20	46,000	92,000	69,000	138,000	101,200	202,400
2019	547	20	109,400	218,800	164,100	328,200	240,360	481,360
2020	362	26	94,120	188,240	141,180	282,360	207,064	414,128
2021	251	33.5	84,085	168,170	126,127.5	252,255	184,974	369,974
Contribution			€348,805	€697,610	€523,207.5	€1,046,415	€767,371	€1,534,742

Results

Low scenario underestimate, based on a sequestration rate of 10 Mt of CO_2 [19,38], it is estimated a single cultivated crop could sequester a total of 14,660 million Mt of CO_2 and a double crop could have sequestered 29,320 million Mt of CO_2 from 2017 to 2021.

Mid scenario mid estimates, based on a sequestration rate of 15 Mt of CO_2 [39,40], it is estimated a single cultivated crop from 2017 to 2021 could sequester a total of 21,900 million Mt of CO_2 and a double crop could have sequestered 43,980 million Mt of CO_2.
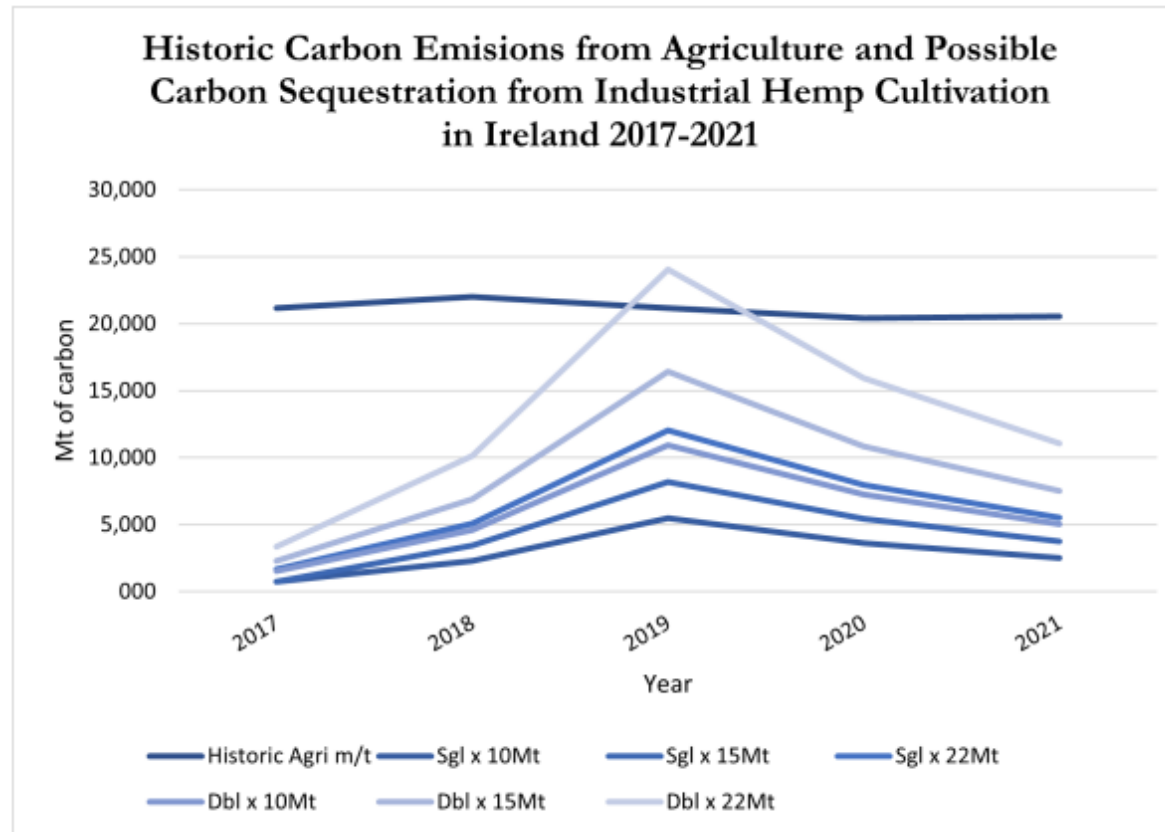
High scenario overestimates, based on a sequestration rate of 22 Mt of CO_2 CO2e per hectare [16–19,22], it is estimated a single cultivated crop could sequester up to 32,252 million Mt of CO_2 and a double crop could have sequestered a total of 64,504 million Mt of CO_2 from 2017 to 2021

Results

Historic Carbon Emisions from Agriculture and Possible Carbon Sequestration from Industrial Hemp Cultivation in Ireland 2017-2021

Results

Potential Economic Contribution of Industrial Hemp Cultivation in Ireland from 2017 to 2021 in terms of carbon tax (Euros)
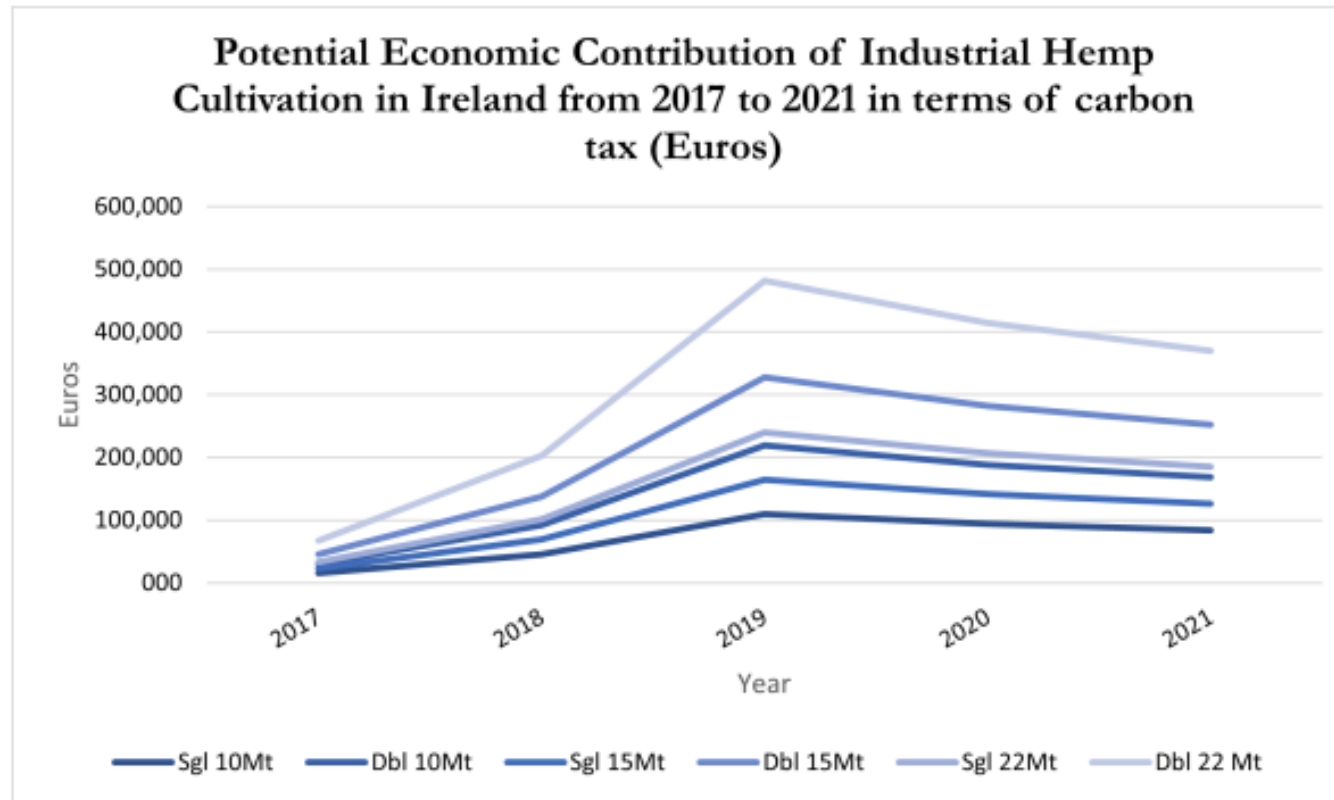
Limitations

Croplands have been shown to be net emitters of CO2 of between 1 to 3 tonnes CO2 hectares per year [72].

Hemp cultivation in Ireland gives rise to annual CO2 emissions of almost 3 tonnes CO2e, intermediate between Miscanthus and SRC (both approximately 2 tonnes CO2e per year) and sugar beet and OSR (both approximately 3.5 tonnes CO2e per year, respectively) [23].

Limitations

CO2 values absorbed by 1 hectare of hemp vary considerably according to the agronomic practices adopted and the biomass produced per hectare.

CO2 sequestration potential is highly dependent on location, climate conditions and farming practices.

Carbon storage in soils is hard to measure because its a slow process and also due to the variation in the use of fertilisers.

The different combinations make the calculations complex, and methodological assumptions may lead to a wide range of results expressed on a per hectare basis [31].

Limitations

High biomass yields are essential in achieving high CO2 emissions savings.

The use of fertilisers can reduce this saving, an exact quantification of CO2 sequestration is not possible considering the number of variables involved.

It is unlikely that, from literature data alone, an accurate assessment of hemp's ability to sequester CO2 can be made due to the different methods utilised and the cultivation environment.

Limitations

Studies have shown terpenes found in hemp are a form of Volatile Organic Compounds (VOC).

Researchers in Colorado measured monoterpenes in the air at Cannabis Cultivation Facilities (CCFs) and found the total monoterpene mixing ratios were 4 to 8 times greater surrounding CCFs than at a background area.

Due to differences in strains or life cycles, monoterpene composition analysis revealed regional diversity, implying that various clusters of CCFs may have different monoterpene emission patterns.

Limitations

Hemp is a crop that requires a lot of water and nutrients to grow.

Due to cannabis cultivation's recent popularity, plant pathogens are becoming more prevalent and severe.

Cultivating industrial hemp can lead directly to soil erosion which negatively affects land use.

Opportunities

However, hemp can also have the ability to absorb and store heavy metals from the soil.

Removing toxins from the soil has shown promise in small-scale testing in Italy and the United States.

Research shows that hemp crops require little potassium [88]

Reducing cultivation emissions through the use of organic fertilisers could further increase net CO2 abatement by up to 1.5 tonne CO2e per hectare per year. [89]

Stem material from hemp can be harvested in large quantities, at between 10 Mt and 14 Mt tons per hectare. Ref. [57]

Recommendations

To improve compliance, public safety, environmental outcomes, and rural development in hemp cultivation

Policy efforts to reduce administrative burdens of compliance, such as

• streamlining licensing processes

• extending agricultural support services

• supporting farmer collectives, deserve more attention

Future Work

Behaviour over Time Graphs (BoTGs) are created early in the planning stages of a research study, project, or programme to understand the situation at hand better.

The BoTGs in this case study are an initial step to understanding this complex system and can be used as a strand in a multi-layered approach to understanding a potential solution to carbon sequestration efforts in Ireland.

Future Work

Further work will be needed to include this information in the emission inventory for CO_2 emissions modelling.

The BoTGs can be further used to engage stakeholders in discussions in the form of Group Model Building workshops.

Modelling work would also help ascertain **future** benefits and profits obtained from cultivating industrial hemp in Ireland.

Referenced papers in this presentation are available at https://www.mdpi.com/2071-1050/14/7/4159

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