

Correction

Correction: Madden et al. A Systems Thinking Approach Investigating the Estimated Environmental and Economic Benefits and Limitations of Industrial Hemp Cultivation in Ireland from 2017–2021. *Sustainability* 2022, 14, 4159

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The authors would like to make the following corrections to the published paper [1]. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. Rather than million tonnes used in part of the study, kilotonnes should have been used. A million tonnes have been amended to kilotonnes (kt) and tonnes (t) throughout the paper, and the figures. Some detailed changes are as follows:

1. Missing Citation

In the original publication, [37] was not cited. The citation has now been inserted in 2. *Material and Methods, Data Collection and Analysis, Paragraph 1*.

Replacing

The EPA data is accessible to the public through the national open data portal www.data.gov.ie, accessed on 20 January 2022. Ireland's overall estimated CO₂ emissions until 2040 are updated in the Greenhouse Gas Emissions projections 2019–2020 [12].

with

The EPA data used for the study is based on the Greenhouse Gas Emissions final report 2020 [37], which was submitted by the EPA in March 2022. Ireland's overall estimated CO₂ emissions until 2040 are updated in the Greenhouse Gas Emissions projections 2019–2020 [12].

2. Missing Citation

In the original publication, [39] was not cited. The citation has now been inserted in 2. *Material and Methods, Data Collection and Analysis, Paragraph 2* and the corrected Paragraph 2 should read:

The unit of measurement for carbon emissions is carbon dioxide CO₂. For this study, each carbon unit is equal to one tonne (t) of CO₂. The International System of Units (SI) base unit for mass is kilograms (kg), 1000 kg equals 1 tonne [39]. Globally CO₂ emissions are measured in Gigatonne (Gt), 1 Gt is equal to 1 billion tonnes, 1 Megatonne (Mt) is equal to 1 million tonnes and 1 kilotonnes (kt) is equal to 1000 tonnes. One tonne of CO₂ that has been removed from the atmosphere equivalent is measured as CO₂e. Other greenhouse gases (GHGs) are quantified in terms of their Global Warming Potential (GWP) over 100 years as equivalents of carbon dioxide CO₂. By definition CO₂ has a GWP of 1 CO₂ emission, CO₂ sequestration is measured in tonnes (t), land use is measured in hectares (ha) while carbon taxes are calculated in euros per tonne. The carbon sequestration rate is calculated at 10 t, 15 t and 22 t per ha annually. The land area of Ireland is 6.9 million hectares, of which 4.9 million hectares or about 69% of total land area is used for agriculture and 773,229 hectares or about 11% of total area for forestry [40].



Citation: Madden, S.M.; Ryan, A.; Walsh, P. Correction: Madden et al. A Systems Thinking Approach Investigating the Estimated Environmental and Economic Benefits and Limitations of Industrial Hemp Cultivation in Ireland from 2017–2021. *Sustainability* 2022, 14, 4159. *Sustainability* 2022, 14, 13551. <https://doi.org/10.3390/su142013551>

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3. Missing Citation, Text Correction, and Table Caption Correction

In the original publication, [40] was not cited. The citation has now been inserted in 3. Results, 3.9. Hemp Cultivation in Ireland, Paragraph 2 and Table 2 Caption.

Replacing the Paragraph 2:

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 as seen in Table 2.

with

CO₂ emissions and removals associated with land use, land use change and forestry (LULUCF), are reported in Ireland's greenhouse gas emissions inventory, including emissions and removals associated with Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land use. In a 2020 submission which relates to the previous year (2019) the land area of Ireland was 6.9 million hectares, of which 4.9 million hectares or about 69% of total land area was used for agriculture and 773,229 hectares or about 11% of total area for forestry [40] accessed 26 May 2022. The total land use of industrial hemp cultivation in Ireland at its peak in 2019 represented 547 hectares or approximately 0.0079% of total land use and 0.011% of agricultural land use as seen in Table 2.

Replacing Table 2 caption:

Table 2. Industrial hemp cultivation land use in Ireland 2019.

with

Table 2. Industrial hemp cultivation estimated percentage (%) land use in Ireland 2019. Source: Total land use, agriculture and forestry land use obtained from land use change and forestry (LULUCF) [40] accessed 26 May 2022, which was used to inform the calculation percentage of the amount of industrial hemp cultivated in Ireland.

4. Error in Table

Table 2 was changed to reflect new data. The corrected **Table 2** appears below.

Land Use	Hectares Ha	Percentage %
Total land	6,900,000	100
Agriculture	4,900,000	69
Forestry	773,229	11
Industrial hemp % of total land	547	0.0079
Industrial hemp % of agriculture	547	0.011

5. Text Correction

Clarification was given to citation [23] in *Introduction, Paragraph 3*, highlighting the research was a Life Cycle Analysis study. And the corrected Paragraph 3 which was divided into two paragraphs should read:

In the 1990s, hemp cultivation returned to the European Union (EU), and since 2016, Irish farmers can apply for a license to cultivate hemp. Industrial hemp is a strain of *Cannabis Sativa* that contains lower concentrations of tetrahydrocannabinol (THC), the narcotic component of cannabis and can be utilised as a carbon sink [16]. Hemp can sequester between 10 tonnes (t) and 22 t of CO₂ per hectare [17–21], making it more efficient at CO₂ sequestration than agroforestry [17,22]. In Ireland [23] researched industrial hemp as an energy crop by means of Life Cycle Assessment found that hemp production in Ireland might boost net CO₂ abatement by up to 21 t CO₂e annually by replacing 25% of oilseed rape (OSR) and sugar beet production. Hemp does not have to compete with food sources when it is integrated into food crop rotations.

The United Nations Commission on Narcotic Substances' decision in December 2020 to remove medicinal cannabis from a category of harmful drugs (Schedule IV of the Single Convention on Narcotic Drugs, 1961) has reignited interest in cultivating the cannabis plant [24]. However, there is little research on the environmental and economic benefits of industrial hemp for CO₂ sequestration. In Ireland, 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, this study aims to answer how industrial hemp has been helpful to carbon sequestration efforts in Ireland, which has a problem with rising CO₂ emissions from agriculture and international financial, legal obligations and environmental policies to maintain. If industrial hemp can sequester CO₂ at a rate of up to 22 t [17–21] per hectare and the current carbon tax is at a rate of €33.50 per tonne [26] then there may be unrecognised environmental and economic benefits in cultivating hemp for CO₂ sequestration in Ireland.

6. Text Correction

Clarification was given to citation [32], highlighting the research was a Life Cycle Analysis study. A correction has been made to *Introduction, the last Paragraph*.

Replacing:

When hemp is grown on a large scale and under certain conditions, it can more than double the Volatile Organic Compounds (VOCs) rate in the atmosphere; these calculations are not within the scope of this study.

with

The results are provided as a means of wide ranges which made it possible to draw insights from the historical data to ascertain the environmental and economic benefits and possible emerging implications of cultivating industrial hemp in Ireland. When hemp is grown on a large scale and under certain conditions, it can more than double the Volatile Organic Compounds (VOCs) rate in the atmosphere [32]; these calculations are not within the scope of this study.

7. Text Correction

For anonymity, a job title associated with the Health Products Regulatory Authorities data was removed. A correction has been made to *2. Materials and Methods, Data Collection and Analysis, the last Paragraph*.

Replacing:

There was no data available for the number of hectares cultivated for 2016. Email correspondence was received from the (Acting) Health Products Distribution Manager, Wednesday 12 May 2021 with 2016 to 2020 data and email correspondence was received Wednesday 13 October 2021 regarding 2021 data.

with

There was no data available for the number of hectares cultivated for 2016. Email correspondence was received from the Health Products Regulatory Authority (HPRA), Wednesday 12 May 2021 with the data for 2016 to 2020 and email correspondence received Wednesday 13 October 2021 regarding data for 2021.

8. Text Correction

For anonymity, a job title associated with the Health Products Regulatory Authorities data was removed. A correction has been made to *3. Results, 3.9. Hemp Cultivation in Ireland, Paragraph 1*.

Replacing:

The Health Products Regulatory Authority (HPRA) on behalf of the Department of Health process license applications to cultivate Hemp in Ireland. Data was requested from the HPRA, and email correspondence was received from the (acting) Health Products Distribution Manager on 12 May 2021 relating to the data from 2016 to 2020. Another email correspondence was received on 13 October 2021 regarding data for 2021. The number of licenses issued, and area of land used to cultivate industrial hemp in Ireland since licensing was introduced in 2016 is as follows:

with

The Health Products Regulatory Authority (HPRA) on behalf of the Department of Health process license applications to cultivate industrial hemp in Ireland. Data was requested from the HPRA, and email correspondence was received on 12 May 2021 relating to the data from 2016 to 2020. A second email correspondence was received on 13 October 2021 regarding data for 2021. The number of licenses issued and area of land used to cultivate industrial hemp in Ireland since licensing was introduced in 2016 is as follows:

9. Error in Figure 1

In the original publication, there was a mistake in Figure 1 as published. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. The corrected Figure 1 appears below.

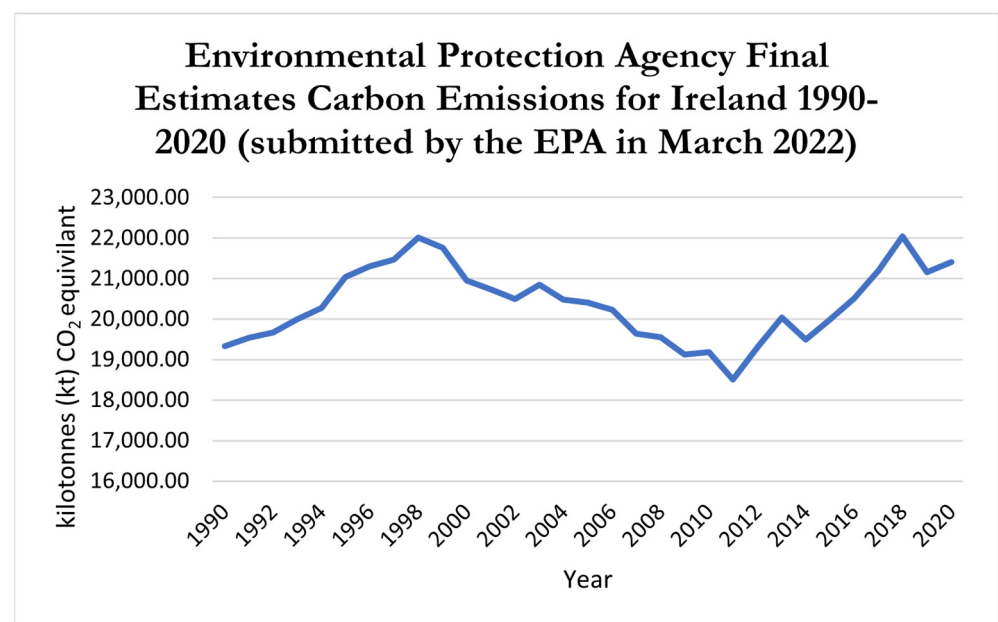


Figure 1. Behaviour over Time Graph (BoTG) historic carbon emissions from agriculture in Ireland 1990–2020 (final submission) 2022 [37].

10. Error in Figure 2

In the original publication, there was a mistake in Figure 2 as published. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. The corrected Figure 2 appears below.

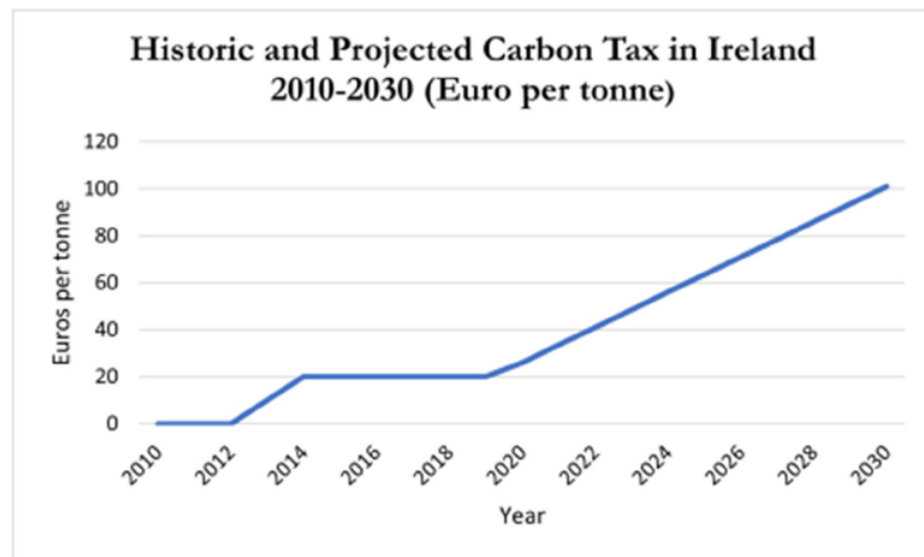


Figure 2. Behaviour over Time Graph (BoTG) historic and projected carbon tax from 2010 through to 2030.

11. Error in Figure 3

In the original publication, there was a mistake in Figure 3 as published. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. The corrected Figure 3 appears below.

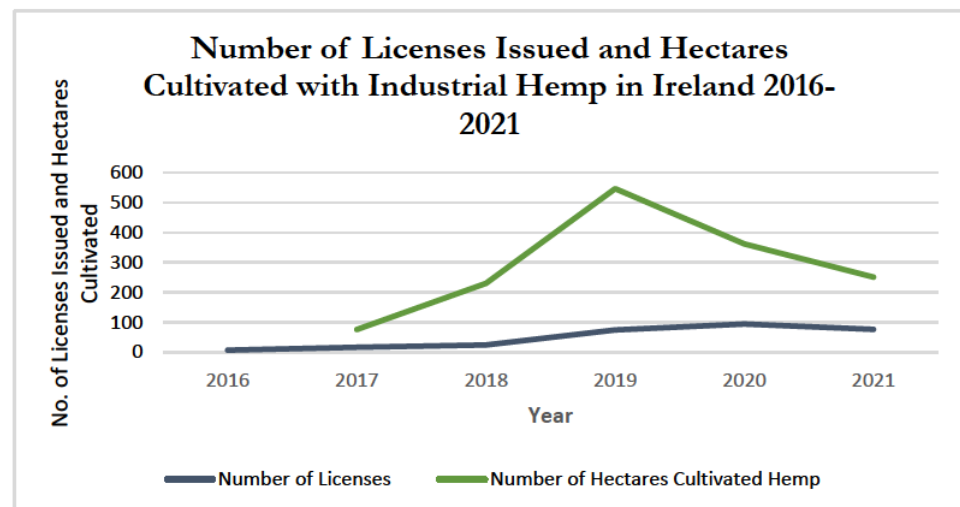


Figure 3. Behaviour over Time Graph (BoTG) illustrating the number of industrial hemp licenses issued in Ireland between 2016–2021, the number of industrial hemp licenses issued is shown in grey and the amount of hectares cultivated with industrial hemp is shown in green. Data was requested from the HPRA, and email correspondence was received on 12 May 2021 relating to the data from 2016 to 2020. A second email correspondence was received on 13 October 2021 regarding the data for 2021.

12. Error in Figure 4

In the original publication, there was a mistake in Figure 4 as published. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. The corrected Figure 4 appears below.

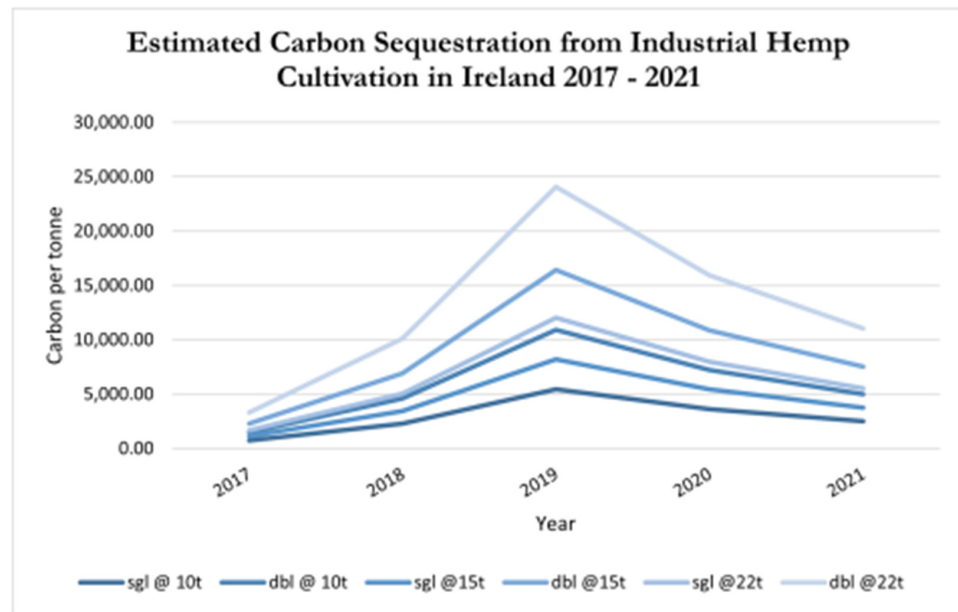


Figure 4. Behaviour over Time Graph (BoTG) estimated carbon sequestration from industrial hemp cultivation in Ireland at CO₂ sequestration rates of 10 tonnes (t), 15 t and 22 t from 2017 to 2021.

13. Error in Figure 5

In the original publication, there was a mistake in Figure 5 as published. An error occurred with a unit of measurement regarding kilotonnes not transposed correctly between software. The corrected Figure 5 appears below.

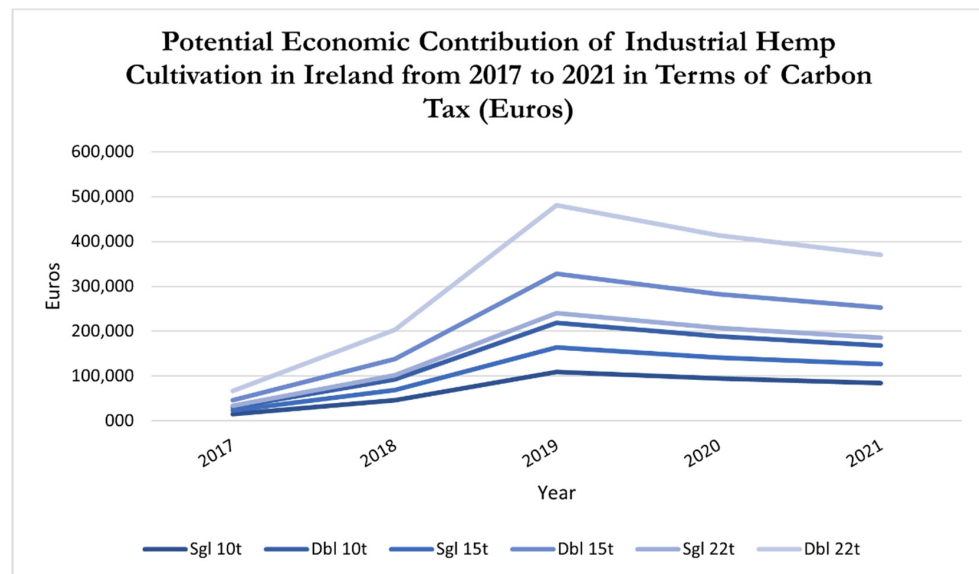


Figure 5. Behaviour over Time Graph (BoTG) estimated financial contribution for carbon emissions in terms of carbon tax credit in Euros.

14. References Correction

New [37], [39] and [40] should be added to the Reference Section. With this correction, the order of some references has been adjusted accordingly.

37. Environmental Protection Agency. 1990–2020 Final Submission 2022, Submitted 15/03/2022. 2022. Available online: <https://www.epa.ie/publications/monitoring-assessment/climate-change/air-emissions/greenhouse-gas-emissions-final-2020.php> (accessed on 26 May 2022).

39. European Union (EU). Units of Measurement in the EU 2019. Available online: <https://eur-lex.europa.eu/EN/legal-content/summary/units-of-measurement-in-the-eu.html> (accessed on 26 May 2022).

40. Government of Ireland. Information on LULUCF Actions to Limit or Reduce Emissions and Maintain or Increase Removals from Activities Defined under Decision 529/2013/EU, Ireland 2020 Submission 2020. Available online: <https://assets.gov.ie/129086/3dd0465c-6999-4ee5-a735-2fcef5385f26.pdf> (accessed on 26 May 2022).

The authors would like to express their gratitude to the correspondents for finding the error. The authors state that the scientific conclusions are unaffected. This correction was approved by the Academic Editor. The original publication has also been updated.

Reference

1. Madden, S.M.; Ryan, A.; Walsh, P. A Systems Thinking Approach Investigating the Estimated Environmental and Economic Benefits and Limitations of Industrial Hemp Cultivation in Ireland from 2017–2021. *Sustainability* **2022**, *14*, 4159. [CrossRef]