ZERO WASTE ALLIANCE IRELAND

Towards Sustainable Resource Management

ZWAI
ZERO WASTE ALLIANCE IRELAND

Submission to the Department of Environment, Climate and Communications, the Department of Agriculture, Food and the Marine, and the Bioeconomy Implementation Group in Response to the Public Consultation on the National Bioeconomy Action Plan 2023-2025

27 January 2023

Zero Waste Alliance Ireland is a member of

EEB European Environmental Bureau

and

IEN Irish Environmental Network

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Bioeconomy Action Plan Consultation,
Sectoral Policy and Land Use Division,
Department of Environment, Climate and Communications,
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Dublin 2,
D02 X285.

BY EMAIL TO:
bioeconomy@decc.gov.ie

Dear Sir / Madam,

Response to Public Consultation on the National Bioeconomy Action Plan 2023-2025

Submission by Zero Waste Alliance Ireland to the Department of Environment, Climate and Communications, the Department of Agriculture, Food and the Marine, and the Bioeconomy Implementation Group

On behalf of Zero Waste Alliance Ireland (ZWAI), we attach our submission in response to the public consultation on the National Bioeconomy Action Plan 2023-2025.

ZWAI is very pleased to have the opportunity to respond to this important public consultation, and the intention of our submission is to provide wide-ranging observations on many aspects of this important plan, as set out in the consultation and discussion document.

We are also very pleased to note that the public consultation is being conducted by three agencies working together, namely, the Department of the Environment, Climate and Communications (DECC), the Department of Agriculture, Food and the Marine (DAFM) and the Bioeconomy Implementation Group (BIG); and that the consultation is being carried out in line with Aarhus guidelines for public

engagement. However, we would like to see the Bioeconomy Action Plan expanded to include an "All-of-Government" approach, similar to the Climate Action Plan, and the Government's proposals for waste reduction and the Circular Economy. In fact, it is difficult to see which government departments should not be engaged one way or another with Ireland's Bioeconomy Action Plan.

In the attached observations, we also wish to draw the attention of the two Departments and the Bioeconomy Implementation Group to the need for reform of Ireland's agricultural and forestry policies and programmes, as these are key to the effective formulation and implementation of the future Bioeconomy Action Plan. Other policy areas, such as energy security, where we are especially concerned about the waste of energy, and the inefficient use of energy, must also be closely integrated with the Bioeconomy Action Plan.

As described in our submission, it is our considered view that we have several closely-linked crises in Ireland: a climate crisis, biodiversity crisis, a critical raw materials crisis, an energy crisis, a food security crisis, a public health crisis, and an inequality crisis. Even if you consider that the term 'crisis' may not be appropriate for all of these policy areas, it is obvious and clear that urgent action is needed; and, particularly in the areas of climate and biodiversity, we have approached critical points where system change has become close to tipping points and may be irreversible.

The fact that these 'crises' are linked (and are impacting the country at different rates and timescales) should not prevent the development and emergence of a strong coherent policy to address all of them in a practical and integrated manner.

We have found it disappointing that the consultation document does not appear to display the necessary sense of urgency required to deal with reviewing and implementation of the Bioeconomy Action Plan. The document unfortunately has been written with an excessive amount of business jargon, making the language turgid and off-putting; and we hope that this kind of language will not find its way into the Action Plan when it has been written and published.

The bases of our bioeconomy are other living creatures, whether in the soil, on the land surface, in water, and in our oceans and seas; and we get a sense in the document that these are mainly to be exploited for profit, with an occasional "nod" in the direction of sustainability. The emphasis on promoting growth in the bioeconomy, and on production and export of increasingly greater quantities of products, takes no account of the adverse effects of transportation, nor the fact that we live on a finite world; and we must live within the carrying capacity of the planet.

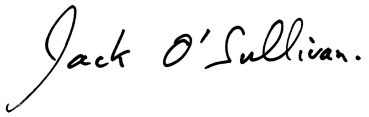
It is our submission that a much more ecological and earth-friendly approach to the bioeconomy is needed, based on a growing awareness of the vulnerability and limitations of our planet's supporting ecosystems; and we can describe this awareness as "Earth Literacy" and "Ocean Literacy". Without a high level of

understanding and awareness, and a science-based approach, our bioeconomy policies and programmes will either fail or have damaging consequences.

We would be grateful if you could note that this letter forms part of our submission.

We look forward to your acknowledgement of the submission, and to seeing in due course the final version of the bioeconomy policy; while taking into consideration the over-arching importance of addressing climate change.

Yours sincerely,



Jack O'Sullivan

On behalf of Zero Waste Alliance Ireland.

ZERO WASTE ALLIANCE IRELAND

Towards Sustainable Resource Management

Submission to the Department of the Environment, Climate and Communications and to the Department of Agriculture, Food and the Marine in Response to the Public Consultation on Ireland's National Bioeconomy Action Plan 2023-2025

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ZERO WASTE ALLIANCE IRELAND

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27 January 2023

1. INTRODUCTION

When the Department of the Environment, Climate and Communications and the Department of Agriculture, Food and the Marine jointly announced a public consultation on Ireland's National Bioeconomy Action Plan 2023-2025, we initially saw this consultation as external to the area in which Zero Waste Alliance Ireland normally contributes to debates and consultations on policy issues.

Our primary areas of work are focussed on prevention of waste, and on the elimination of wasting or discarding substances, materials, made objects (natural or man-made) and products of every description; and we especially oppose their end-of-life fate by incineration or landfilling, resulting in the continuing extraction and processing of yet more raw materials to replace them. Closely allied with these areas of work are our promotion of the Circular Economy, and our support for schemes such as "deposit and return" which would have the effect of increasing the rate at which materials and objects are re-used and recycled. These positive activities may be summarised as promoting the transition from a wasteful linear to a more efficient circular economy, together with accompanying changes in how our society values and uses non-living and living (plant-based and animal-based) materials, and the manufactured goods we produce from them.

The "bioeconomy" is a term which has recently come into extensive use; and it means utilising renewable biological resources from land and sea, including wild and planted crops, forests, fish, animals and micro-organisms to produce food, materials and energy. Even though this is quite a wide definition, we will argue in our submission that the bioeconomy should also include ecosystem services essential for human life; for example, air purification, temperature control,

amenities, and other important contributions to human well-being. And if we truly see the way in which global ecosystems are integrated, the bioeconomy must also embrace services to other living creatures on the planet.

When we consider how much of these biological resources and services we use inefficiently, or utilise in ways which damage the environment and living systems, it becomes clear that the more efficient, wise and sustainable use of the materials and services which we obtain from other living organisms, and the avoidance of waste at every stage, are becoming more essential to our own survival, and to the survival of the natural world on which we depend.

We can therefore establish an obvious link between wise and sustainable uses of bio-materials and services (including reducing our demand), so that the more efficient and less wasteful our society becomes, the less land and water spaces are needed to sustain their production.

While it may appear at first glance that waste and resources management, and the achievement of bioeconomy-related goals (including the formulation of a sustainable bioeconomy action plan) are not linked, it is our belief that that the two are connected.

Not only must discarded bio-materials be replaced in the continuing cycle of production (if they are not reused, repurposed recycled), but the processes of seeding, growing, harvesting, extraction, transformation, transport, processing, manufacturing and distribution require yet further human effort and energy which could be used more beneficially or avoided completely; and this applies to both plant-based and animal-based bio-materials.

Secondly, Zero Waste Alliance Ireland has always taken the view that caring for the soil, locally and globally, is a beneficial activity essential for both plant and animal abundance, for ecosystem maintenance, and for ensuring continuation of a supply of bio-materials and services. In our submission, we will therefore emphasise the role of soil as a living entity, and the need to prevent soil loss, erosion and contamination.

Thirdly, Zero Waste Alliance Ireland has always taken the view that the term "waste" should encompass not only discarded materials, but should also cover the waste of water and the waste of nutrients contained in wastewater which we discharge to the environment; especially as water and nutrients are essential requirements for living organisms. Also, these are areas in which we have made previous submissions in response to public consultations.

Fourthly, it has always been our policy that any type of wasteful activity (including the wasteful, inefficient or damaging use of biological resources and services) has the potential to have detrimental effects on the Earth's climate, and would have adverse effects on Ireland's food security.

We therefore see this public consultation as a welcome opportunity to provide feedback on a topic in which Zero Waste Alliance Ireland should have an interest.

Widespread failure to use bio-materials and ecosystem services efficiently, to reduce our unnecessary demand on the natural world, and to recover, re-use and recycle discarded substances, materials and products, are symptoms of our European-wide and Irish failure to consider the linked issues of biodiversity loss, scarcity and security. We have also failed to adequately implement the Circular Economy, with a resulting increase in greenhouse gas emissions, serious damage to ecosystems, major loss of biodiversity, changes in sea level, stronger and more frequent storm events, threats to the security of food supplies, damage to human health, and other adverse consequences of climate change.

The slow and insidious loss of species and vulnerable ecosystems (for example the decline in insect and bird numbers, and the destruction of wetlands), and the reduction or loss of the ecosystem services which they provide, has been ongoing for decades; yet, with few exceptions, they have not aroused widespread public concern. In a manner similar to our failure to prevent waste and to implement the Circular Economy, our failure as a nation to protect biodiversity is almost certain to have an adverse effect on our bioeconomy.

As the Department has stated in its call for submissions:[1]

> *"The bioeconomy considers our use of biological resources in a holistic way, supporting food and nutrition security, mitigating, and adapting to climate change, reducing dependence on non-renewable unsustainable resources, managing natural resources sustainably and strengthening competitiveness, creating jobs, and supporting a just transition".*

And the bioeconomy "*is a natural enabler of the transformation to reach net-zero emissions by no later than 2050"*, and also "*an enabler for the Circular Economy"*, which will move our society "*to a more sustainable pattern of production and consumption, including to reduce raw material consumption, to retain the value of resources in the economy for as long as possible and to significantly reduce greenhouse gas emissions".*

Zero Waste Alliance Ireland fully supports these statements, and we would add that **Ireland is in a multiple emergency** (energy, climate, biodiversity, social inequality and human health emergencies) and it is of utmost importance that Government takes immediate and concerted action to comprehensively address these issues.

[1] Bioeconomy Action Plan – Consultation and Discussion Document, Prepared by the Department of Environment, Climate and Communications, 24 Nov 2022.

2. ZERO WASTE ALLIANCE IRELAND (ZWAI)

Zero Waste Alliance Ireland is therefore pleased to have the opportunity to make this submission in response to the Department's public consultation on Ireland's National Bioeconomy Action Plan (NBAP) for the years 2023-2025; and at this point we consider that it is appropriate to describe briefly the background to our submission, especially the history, policy, strategy and activities of ZWAI.

2.1 Origin and Early Activities of ZWAI

Zero Waste Alliance Ireland (ZWAI), established in 1999, and registered as a company limited by guarantee in 2004, is a Non-Government Environmental Organisation (eNGO) and a registered charity.

During the past two decades, ZWAI has prepared and submitted to the Irish Government and to State Agencies many policy observations on waste management, on using resources sustainably, on promoting re-use, repair and recycling, and on development and implementation of the Circular Economy. In recent years, ZWAI has also responded to the European Commission's calls for submissions on a variety of topics in the areas of wastewater, solid wastes, soil health and biological materials.

Our principal objectives are:

i) sharing information, ideas and contacts,

ii) finding and recommending environmentally sustainable and practical solutions for domestic, municipal, industrial and agricultural waste management in Ireland;

iii) lobbying Government and local authorities to implement environmentally sustainable waste management practices, including clean production, elimination of toxic substances, repairing, re-using, recycling, segregation of discarded materials at source, and other beneficial practices;

iv) lobbying Government to follow the best international practice and EU recommendations by introducing fiscal and economic measures designed to penalise the manufacturers of products which cannot be repaired, re-used, recycled or composted at the end of their useful lives, and to financially support companies making products which can be re-used, recycled or are made from recycled materials;

v) raising public awareness about the long-term damaging human and animal health and economic consequences of landfilling and of the destruction of potentially recyclable or re-usable materials by incineration;

vi) investigating, raising public awareness and lobbying Irish Government departments and agencies about our country's failure to take adequate care of vulnerable and essential natural resources, including clean water and air, biodiversity, and soil;

vii) advocating changes in domestic and EU legislation to provide for more ecologically appropriate, environmentally sustainable and efficient uses of natural resources; and,

viii) maintaining contact and exchanging information with similar national networks in other countries, and with international zero waste organisations.

2.2 Our Basic Principles

Human communities must behave like natural ones, living comfortably within the natural flow of energy from the sun and plants, producing no wastes which cannot be recycled back into the earth's systems, and guided by new economic values which are in harmony with personal and ecological values.

In nature, the waste products of every living organism serve as raw materials to be transformed by other living creatures, or benefit the planet in other ways. Instead of organising systems that efficiently dispose of or recycle our waste, we need to design systems of production that have little or no waste to begin with.

There are no technical barriers to achieving a "zero waste society", only our habits, our greed as a society, and the current economic structures and policies which have led to the present environmental, social and economic difficulties.

"*Zero Waste"* is a realistic whole-system approach to addressing the problem of society's unsustainable resource flows – it encompasses waste elimination at source through product design and producer responsibility, together with waste reduction strategies further down the supply chain, such as cleaner production, product repairing, dismantling, recycling, re-use and composting.

ZWAI strongly believes that Ireland should have a policy of not sending to other countries our discarded materials for further treatment or recycling, particularly to developing countries where local populations are exposed to dioxins and other very toxic POPs. Relying on other countries' infrastructure to achieve our "recycling" targets is not acceptable from an ecological or societal perspective.

2.3 What We are Doing

One of our principal objectives is to encourage Irish government agencies, Irish local authorities and other organisations to develop and implement environmentally sustainable resources and waste management policies,

especially resource efficiency, waste reduction and elimination; to promote reuse, repair and recycling, to develop and implement the Circular Economy, and to recognise that climate change and biodiversity loss are existential threats.

As an environmental NGO, and a not-for-profit company with charitable status since 2005, ZWAI also campaigns for the implementation of the UN Sustainable Development Goals, including (but not limited to) Goal 12, Responsible Consumption and Production; Goal 6, Clean Water and Sanitation (having particular regard to the need to avoid wasting water); and Goal 15, to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, to halt and reverse land degradation and halt biodiversity loss.

Zero Waste Alliance Ireland has continued to lobby the Government on the issue of sustainable resource management, and to express our concern at the failure to address Ireland's waste problems at a fundamental level.

ZWAI has responded to many Irish and EU public consultations; and, in its role as an environmental NGO, has given presentations and made submissions on:

1. Proposed amendments to the Irish Building Regulations (February 2016 and October 2021);
2. Submission to the Department of Housing, Planning and Local Government on Water Services Policy (April 2018);
3. How the European Union has addressed the problem of plastic waste (March 2019);
4. Response to public consultation on proposed new environmental levies (Nov-2019);
5. Submission on single-use plastic packaging by the food industry (November 2019);
6. Response to a public consultation by the Department of Housing, Planning and Local Government on significant water management issues in Ireland (August 2020);
7. Submission to Department of Environment, Climate and Communications on the proposed introduction of a deposit and return scheme (DRS) for beverage containers (November 2020), and on the legislative framework and scope of a Deposit Return Scheme in Ireland (May 2021);
8. Submission to the European Commission in response to a public consultation on the revision of the Urban Wastewater Treatment Directive (July 2021);
9. Submission to the Joint Oireachtas Committee on Environment and Climate Action on the general scheme of the Circular Economy Bill (October 2021);

10. Feedback to the European Commission in response to a public consultation on the proposed revision of the EU Regulation on Shipments of Waste (January 2022);

11. Feedback to the European Commission in response to a public consultation on protecting, sustainably managing and restoring EU soils, including comments on the updating of the 2006 EU Thematic Strategy on Soil (February 2022);

12. Feedback to the European Commission in response to public consultation on revision of the EU plant and forest reproductive material legislation (March 2022);

13. Providing feedback to the European Commission on the waste-related environmental performance of Ireland and certain other EU Member States, and the probability of their achieving the 2025 recycling targets and the 2035 landfill target (August 2022);

14. Providing feedback to the European Commission on the need to reduce the waste of unwanted or discarded food, at every stage of the food production process (August 2022);

15. Response to the European Commission's public consultation on an integrated action plan for the management of nutrients (August 2022);

16. Submission to the Department of the Environment, Climate and Communications to support and inform preparation of the 2023 Climate Action Plan (September 2022);

17. Submission to the European Commission on State Aid, in response to the Aarhus Convention Compliance Committee complaint (October 2022);

18. Submission responding to public consultation on Ireland's energy security (October 2022)

19. Submission to the Department of Housing, Local Government and Heritage in Response to the Public Consultation on Ireland's Fourth National Biodiversity Action Plan (November 2022);

20. Presentation on "*Water and Sustainability – A Necessary Alliance"*, delivered at the All-Ireland Water & Wastewater Summit, November 2022;

21. Several presentations on transforming the construction industry so that it could become climate neutral; and,

22. Several submissions on the separation, recovery and reuse of the phosphorus and nitrogen content of wastewater (2019 to 2022).

It will be clear that ZWAI is primarily concerned with the very serious issue of discarded substances, materials and goods, whether from domestic, commercial or industrial sources, how these become "waste", and how such "waste" may be prevented by re-design along ecological principles. These same ecological

principles can be applied to how we abstract and use water, and to the volumes of wastewater produced and nutrients lost as a consequence of these uses. In this submission we consider that similar principles can be applied to the bio-economy, including biological resources and ecosystem services provided by the natural living world.

ZWAI is represented on the Irish Government's Water Forum (An Fóram Uisce) by one of our Directors; ZWAI is a member of the **Irish Environmental Network** (IEN), and is funded by the Department of Communications, Climate Action and the Environment through the IEN.

In 2019 ZWAI became a full member of the **European Environment Bureau** (EEB); and a member of the **Waste Working Group** of the EEB. Through the EEB, we contribute to the development of European Union policy on waste and the Circular Economy. In 2021, the EEB established a **Task Force on the Built Environment**; ZWAI is a member of this group, and we contribute to discussions on sustainability of construction materials, buildings and on the built environment.

3. DEFINING THE BIOECONOMY

In the Department's consultation and discussion document on the Bioeconomy Action Plan, the bioeconomy is described as covering:

> *"all sectors (including agriculture, horticulture, forestry, fisheries & aquaculture) and systems (including nature, land, food, energy, built environment, health) that rely on biological resources (from animals, plants, insects, micro-organisms and derived biomass, organic waste), their functions and principles.*
>
> *The bioeconomy encompasses these sectors, systems, associated services and investments to conserve, produce, regenerate, use, process, distribute or consume biological resources including ecosystem services. Bioeconomy allows economic and social value to be added to biological resources providing sustainable solutions (including information, products, processes, and services) in and across all economic sectors in a sustainable, renewable, and circular manner.*
>
> *The bioeconomy considers our use of biological resources in a holistic way, supporting food and nutrition security, mitigating, and adapting to climate change, reducing dependence on non-renewable unsustainable resources, managing natural resources sustainably and strengthening competitiveness, creating jobs, and supporting a just transition".*[2]

This is a good definition, with which we would concur; though we would argue that the definition of the bioeconomy should be extended to include services to other living creatures on the planet, for the reason that ecosystems function in an integrated way, with many living organisms providing food, shelter and other services and materials to other living organisms. We might refer to this as the "natural bioeconomy" of which the human-centred bioeconomy forms a part.

Zero Waste Alliance Ireland also supports the statements that "*environmental sustainability is an integral, core principle of the bioeconomy*", and that the "*amount of biomaterial extracted should not have a negative impact on our biological resources; it should not exceed the capacity of the environment to replenish itself; and should cause no lasting damage to an environment*".[3]

[2] Bioeconomy Action Plan – Consultation and Discussion Document, section 2, page 4. Prepared by the Department of Environment, Climate and Communications, 24 Nov 2022.

[3] Bioeconomy Action Plan – Consultation and Discussion Document, section 6.1, page 11. Department of Environment, Climate and Communications, 24 Nov 2022.

4. AREAS OF THE BIOECONOMY ACTION PLAN

The proposed areas of implementation of the Bioeconomy Action Plan discussion document are listed as:

1. Governance;
2. Research, development & innovation;
3. Nature, climate & circular economy;
4. Agriculture, forestry & the marine;
5. Communities;
6. Industry & enterprise; and,
7. Knowledge & skills.

Other principles mentioned in the discussion document are the "*Precautionary Principle"* (a risk management approach to prevent policies or actions causing harm to the public or the environment); and the "*Food First Principle"* (giving priority to food and nutrition security by improving the availability of and access to a safe and healthy food supply for citizens).

Using these proposed areas of implementation as a guide, we have structured our submission as follows:

1. Governance and management of the bioeconomy (section 5);
2. Soil, agriculture, forestry and land use (section 6);
3. Seas, oceans and the marine bioeconomy (section 7);
4. The bioeconomy and climate change (section 8);
5. The essential role of circularity – making the bioeconomy circular in action (section 9);
6. Importance of research, development and innovation in the circular bioeconomy (section 10);
7. Awareness raising; developing our knowledge & skills; earth literacy and ocean literacy; and empowering communities (section 11); and,
8. Summary and recommendations (section 12).

5. GOVERNANCE AND MANAGEMENT OF THE BIOECONOMY

The Department's consultation document states that the government's proposed vision for the bioeconomy is to assist Ireland's "*ambition to be a global leader for the bioeconomy"*, by harnessing Ireland's natural resources, giving the country a "*competitive advantage"* through "*fully exploiting the opportunities available"*. This section of the consultation document further states that "*an important objective of the bioeconomy is to move Ireland beyond simply focusing on complying with targets, to integrating sustainable economic development into our economic model as we transition to a low carbon and circular economy".*

From our perspective, these statements are ambiguous and narrow. Firstly, it is very hard to consider how Ireland could have an ambition to be a global leader in the area of bioeconomy, when our overall use of the bioeconomy is very "patchy"; i.e., there are some areas in which we are already leading, and can continue to lead, while there are other areas where we are seriously lagging behind, or where we were a leader, but lost the initiative.

5.1 An Early Example of the Bioeconomy – Alcohol from Potatoes as a Renewable Source of Energy for Vehicles

It is therefore worthwhile remembering that Ireland was a bio-economy leader for several decades during the 20th century, when we developed alcohol production using potatoes as a raw material. The alcohol was added to what was then termed "motor spirit", but which we now know as "petrol", in a proportion determined by the relevant Government minister, and all companies producing or selling "motor spirit" were required to purchase the necessary amount from a state company, Chemicí Teoranta, at a price determined by the Minister.[4]

Ireland was therefore an early leader in using a biofuel to displace fossil fuel, even though the primary purpose of the legislation and the establishment of Chemicí Teoranta in 1938 was to utilise potatoes, in order to provide for Irish farmers a market for their potatoes at a time when the British government had closed its border to this Irish crop. The company built five plants for the production of alcohol (at Cooley, Co. Louth; Carrickmacross, Co. Monaghan; Carndonagh, Co. Donegal; Labbadish, Co. Donegal; and at Corroy, Ballina, Co. Mayo); alcohol production commenced in 1938; these plants functioned very efficiently for many decades, until Ceimici Teoranta went into voluntary liquidation

[4] Industrial Alcohol Act, 1934, number 40 of 1934. It is not generally known that the original name of the state company was Monarchana Alcóil na hÉireann Teoranta, and it was changed to Ceimicí Teoranta in 1947.

in 1986; and the Cooley plant was bought in 1987 by John Teeling who converted it to the Cooley distillery. The other four plants had been closed down earlier.[5]

5.2 A Second Early Example of the Bioeconomy – The Production of Sugar from Sugar Beet

Another area of the bio economy in which Ireland was an early leader was the production of sugar from sugar beet, a crop which could be grown, and was grown, very successfully in Ireland.

Sugar beet production was introduced 90 years ago following the establishment of Comhlucht Siúicre Éireann, Teoranta in 1933, following a decision by the Government in that year to create a national sugar industry capable of meeting the country's total requirements from domestic output. The first plant built, at Carlow, was not producing enough sugar to meet the country's needs at the time; but the Minister for Industry and Commerce, Seán Lemass, convinced the government to build three more sugar beet processing plants at Mallow, Thurles and Tuam. These provided badly needed employment at the time, while the crop provided independence in sugar production, and also a useful cash crop on farms.

The following statement by Seán Lemass to the Dáil in 1933 expressed the post-World-War-2 mood and vision of social responsibility in Ireland at that time:

> *"In no country in the world is sugar an economic proposition, if we regard it from purely an economic point of view. But there are other points of view besides the views of the accountants. And we are going to provide employment, it will be a cash crop for farmers, and it will indirectly create new business".*[6]

For tillage farming, and as a formerly very significant contributor to Ireland's bioeconomy, sugar beet is an important rotation crop, suited to inclusion in a yearly-changing cycle of crops, including for instance, barley, wheat or potatoes. Harvest started in September and went on until December. Beet was a cash crop; the Irish Sugar Company provided seed, harvesting assistance and transport, and farmers were paid an advance, which was of vital importance to small-scale farmers.

Total sugar sales quickly reached approximately 200,000 tonnes per annum, with a reasonable rate of growth over the years. Comhlucht Siúicre Éireann, before it was closed down and sold off, had a virtual *de facto* monopoly of the sugar market

[5] Oireachtas Committee Reports; Joint Committee on Commercial State-Sponsored Bodies; Report No. 05 - Ceimicí Teoranta, 1979.

[6] Bittersweet Beet: A History of Irish Sugar. Caitriona Devery, FEAST Journal. http://feastjournal.co.uk/article/bittersweet-beet-a-history-of-irish-sugar/

in all of Ireland, including a very substantial share of the market in the North of Ireland.

The major by-products of the sugar process — pulp and molasses — were utilised as processed animal feed components, widely used in livestock, pig and bloodstock feeds. The company also researched sugar extraction from the crop, examined the soil requirements of sugar beet growth, and Ireland soon became a leader in this bio-industry.

A deep recession in Ireland in the 1980s made the industrial context difficult and compounded the challenge of meeting the sugar quota system. A decision was made by management to concentrate production and close the two smaller factories, Tuam in 1986 and Thurles in 1989.

A further damaging decision was made in 1991 when the Irish Sugar Company was floated on the stock market under the name of Greencore, reflecting the ideology of privatisation which became prevalent in the 1980s. Under the 2005-2006 CAP reforms, the EU planned to reduce its sugar production by 25%; guaranteed prices for sugar and export subsidies were also reduced, impacting adversely on beet and sugar prices.

Greencore quickly made a decision to close the Carlow factory and move all production to Mallow; and, in 2006, Greencore decided to stop sugar production entirely and close the allow plant. Selling the lands on which these former sugar factories were located was highly profitable for Greencore shareholders and directors, but spelled disaster for farmers and workers.

The final sugar beet campaigns and the closure of the Mallow and Carlow factories brought an end to a key part of Irish industrial history, and especially an industry that today would be seen as a sustainable bio-industry. A subsequent report by the European Court of Auditors concluded that the decision to completely close the Irish sugar beet industry was not necessary, and this report was seen as a bitter afternote to the decisions that saw the end of Comhlucht Siúicre Éireann.[7]

5.3 Some Lessons from these Early Examples of the Industrial Bioeconomy

Sugar beet was initially pivotal in the history of agriculture and industry in Ireland, but subsequently became politicised throughout the twentieth and early twenty-first century. The new state began with an undeveloped tillage and industrial sector and a mission to create an independent Ireland. The sugar industry was a particularly Irish form of enterprise; one that integrated agriculture with industry.

[7] Bittersweet Beet: A History of Irish Sugar. Caitriona Devery, FEAST Journal. http://feastjournal.co.uk/article/bittersweet-beet-a-history-of-irish-sugar/

It made sense in a country with a strongly rural self-conception and an intrinsic distrust of the industrial urbanism of its nearest neighbour.

It was also an example of Irish agricultural and industrial cooperation, exploiting a natural resource that changed the economic and social landscape of rural Ireland. It managed the tension between rural and industrial milieus; and, in its early history, the tensions between the social functions of enterprise and the need to be competitive and profitable. The Irish sugar beet industry directly employed many hundreds of staff but also provided over 10,000 additional jobs on farms, in agricultural contracting, haulage and in the service industries. The industry fostered technical enterprises to grow around the factories and it trained professionals who went on to work in other parts of the state and in private enterprise. Although the towns were very badly impacted by the factory closures, echoes remain. The closure of the industry dealt a serious blow to rural Ireland and to the Irish tillage sector.

Our early interest in self-sufficiency, as a new State, while at odds with present-day globalised free trade, resonates with current calls for local food systems and with a sustainable approach to agriculture. The interest in self-reliance of the 1930s and 40s may stem from the trauma of the Famine, fears of reliance on insecure food chains, and a desire to cut ties with Britain.

Growing as much as possible of our own food is now seen as desirable; in terms of environmental and social sustainability, food sovereignty and food security. As noted briefly in our introduction (section 1, page 3), agriculture, economics and public health are intrinsically linked; yet it is noticeable that health and agriculture are very rarely mentioned together, or even in the same context. Human health depends greatly on food, and if the government could support the production of more home-grown, locally produced foods, including high welfare, grass-fed meat, eggs, pesticide-free grains, vegetables, nuts, and fruit; as opposed to pursuing a policy of increasing production without heed to the cost, environmental or otherwise, the outcome is likely to be an improvement in the health of the nation.

The Bioeconomy Action Plan should encourage the type of vision and ambition which enabled the rise of the Irish sugar industry to be brought now to the growth and processing of fruit, vegetables and other cereals that Ireland currently imports on a large scale. Adaptation of our food system towards a more local and sustainable food economy requires a similar resolve. Sugar beet was fuel for social change in Ireland, sustaining and nurturing economic, industrial and social development. Perhaps there is a place for beet in the future agricultural landscape of Ireland, but perhaps even more can be learned by taking its inception as a template, an example of visionary Irish agri-industry that sought to meet social needs.

It is possible that interest in sugar beet production in Ireland may be currently resurging, presenting an opportunity to establish good rotational practices to maximise soil health and profitability. In addition to sugar beet, or as rotational alternatives, some leguminous crops have the potential for high yield with lower N-fertilizer doses. Considering Ireland's cool, wet climate, the ideal legumes for rotation are soybean and clover. Intercropping with clover may result in decreased weeds and increased soil nitrogen, leading to lower herbicide and nitrogen applications.

5.4 How Are Ireland's Forests to be Managed — for Timber, Biomass, Fuel, Recreation, Biodiversity, or a Combination of All of these Uses?

Recently it was announced that 123,000 acres of land would be sold to the Gresham House fund. This will be a major undertaking of private forestry, and control of the land by an investment fund will mean that any investment in forestry will likely be done on a profit making basis. This will mean that the usability of timber will be the priority and not the planting of native trees which best promote Ireland's biodiversity. The private ownership of forestry will also prevent other economic uses for forests such as recreational use for the public which could be guaranteed and encouraged under state ownership. Thus, forestry should be kept under state control to prevent this kind of management of our forests and, by extension, ultimately impacting biodiversity negatively.

The burning of forest biomass (timber, thinnings, or trees grown purely for fuel production) has long been proposed as a way of generating renewable energy. According to the brief on biomass for energy in the European Union; forestry accounts for 60% of all biomass supplied for energy generation purposes.

One major problem is that the burning of wood generates a significant amount of carbon dioxide, along with the depletion of carbon sinks in forests or plantations, in order to supply wood for burning, for industrial purposes or as a fuel for home heating. The use of forest biomass for energy production also prevents it being used as a renewable resource for the manufacture of paper, dwellings, furniture and many other wood products, a high proportion of which can be recycled at the end of their useful lives.

Retrofitting older homes to reduce or eliminate the burning of wood biomass should therefore be encouraged, not only as a step towards reducing dependency on fossil fuels, reducing greenhouse gas emissions, and for making better use of timber and forest products in the bioeconomy.

Planting forests has also amenity benefits, especially in urban areas; and when these small forests are planted, they become part of our bioeconomy.

The idea is simple – take brownfield sites, plant them densely with a wide variety of native seedlings, and let them grow with minimal intervention. The result, according to the post, is complex ecosystems perfectly suited to local conditions that improve biodiversity, grow quickly and absorb more CO_2.

Chief advocate of planting multiple tiny forests is Japanese botanist Dr. Akira Miyawaki. His idea is inspired by the protected areas around churches, temples, shrines and cemeteries in Japan which contain a huge variety of native vegetation that co-exist to produce resilient and diverse ecosystems. This contrasts with the monocultural conifer forests primarily grown for timber – that dominate Japan's landscape.

The popularity of what are called '**Miyawaki forests**' is growing, with many examples in India, Brazil and Europe. Projects such as '**Urban Forests**' in Belgium and France, and '**Tiny Forests**' in the Netherlands, are bringing together parishes and various community groups to plant up grassy corners and neglected patches in their own localities.

In 2017, Minister of State, Mr Andrew Doyle TD, in the Department of Agriculture, Food and the Marine launched a Forest Service project to grant aid landowners and public bodies who want to develop small woodlands. This is a thoroughly beneficial initiative to help biodiversity, fight climate change, boost mental health, build community spirit, provide outdoor education, and give some effect to the vision – "*to safeguard the integrity of creation, and sustain and renew the life of the earth".*

5.5 The Bioeconomy and Food Security

Food security has become increasingly important in the last year, primarily as a consequence of Russia's war on Ukraine. A conflict in certain key food-producing countries can cause sudden shortages in essential foods which leads to massive spikes in costs, which then filters into the general economy of a country.

In sections 5.2 and 5.3 above, we provided a reasonably detailed account of the sugar beet industry, concluding that its closure in Ireland was a critical error for Ireland's self-sufficiency and economy, and we recommend that this industry should be reopened and run by the state.

Wheat production in Ireland is also another example of this failure to develop a sustainable crop, which could contribute significantly to the bioeconomy. For example, in 2021 we imported 90% of our flour from Britain; and as a consequence of Brexit, such importation leaves Ireland very vulnerable to shocks in supply and cost. In order to guarantee food security for the essentials such as bread, we need to incentivise more domestic wheat production and more large-scale flour production in Ireland. This could be done in the form of grants for setting up flour mills and financial incentives to grow wheat.

5.6 Good Governance Should Avoid Over-exploitation

We have given these examples above in some detail to show that the governance of Ireland's bioeconomy has not always been satisfactory or to the benefit of either the country or agriculture. Good decisions have been made at certain periods, while within a few decades the benefits have been dissipated by closure of bio-industries under the influence of a neo-liberal ideology, with no consideration of the social consequences.

When considering the consultation document as a whole, it appears to ZWAI that the proposed policy is too strongly focused on exploitation of those living organisms which are essential for support of the bio-economy. Even though the principle of sustainability and the precautionary principle (doing no harm) are invoked, the emphasis is on exploitation rather than on long-term rational and sustainable use.

This observation is made despite the statement in section 2 (page 4) of the Department's consultation document, which states that:

> *"Bioeconomy allows economic and social value to be added to biological resources providing sustainable solutions (including information, products, processes, and services) in and across all economic sectors in a sustainable, renewable, and circular manner".*

Even though this is an admirable statement, we are concerned that the attribution of social value to the bioeconomy may be overtaken or overwhelmed by policies and programmes more concerned with financial viability, as happened with the alcohol and sugar beet industries.

6. SOIL, AGRICULTURE AND FORESTRY

Despite its importance in nearly all varieties of the bioeconomy, soil receives only a very brief mention in the consultation document (section 6.1, page 11). WE therefore wish to draw attention to the emphasis in EU policy on the importance, vulnerability, and need to protect Europe's soils — including the soils of Ireland of course. Without our soil health, our crops and farm animals would neither thrive nor be productive.

6.1 The EU Soil Thematic Strategy Focus on Soil and Land Degradation

In February 2022, the European Commission began a process of updating the 2006 EU Soil Thematic Strategy[8] to address soil and land degradation in a comprehensive way, and to fulfil EU and international commitments on land degradation, in accordance with the UN Sustainable Development Goal 15.3.

The EU Soil Strategy for 2030 provides a vital background to the Commission's proposal to develop a comprehensive EU legal framework for soil protection and to grant this valuable natural resource the same level of protection as water and air. The reasons for providing such protection, are clear and self-evident, as stated in the Strategy:

> *"Soil and the multitude of organisms that live in it provide us with food, biomass and fibres, raw materials, regulate the water, carbon and nutrient cycles and make life on land possible. It takes thousands of years to produce a few centimetres of this magic carpet.*
>
> *Soil hosts more than 25% of all biodiversity on the planet* [9] *and is the foundation of the food chains nourishing humanity and above ground biodiversity. This fragile layer will be expected to feed and filter drinking water fit for consumption to a global population of nearly 10 billion people by 2050.*
>
> *Healthy soils are also the largest terrestrial carbon pool on the planet. This feature, coupled with their sponge-like function to absorb water and reduce the risk of flooding and drought, makes soil an indispensable ally for climate change mitigation and adaptation.*[10] *Healthy soils therefore*

[8] Thematic Strategy for Soil Protection — Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. COM(2006)231 final. Brussels, 22.9.2006.

[9] FAO (2020). State of knowledge of soil biodiversity – Status, challenges and potentialities.

[10] Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change. Commission Staff Working Document, Impact Assessment Report, accompanying the Communication from the Commission to the European Parliament, the Council, the Economic

integrate part of the Union's climate, biodiversity and also long-term economic objectives".

The need to protect European soils is so important that it has attracted the attention of the European Court of Auditors,[11] and the European Environment Agency;[12] while a European Citizens' initiative "*People4Soil*" gathered the support of more than 500 organisations from 26 EU countries, and collected over 220,000 signatures.[13]

The principal objectives of the European Citizens' initiative were to:

"Recognize soil as a shared heritage that needs EU level protection, as it provides essential benefits connected to human well-being and environmental resilience; develop a dedicated legally binding framework covering the main soil threats: erosion, sealing, organic matter decline, biodiversity loss and contamination; integrate soil related UN Sustainable Development Goals into EU policies; properly account and reduce greenhouse gases emissions from the farming and forestry sectors."

A public invitation in early 2022 to provide feedback on the proposed updating of the 2006 EU Soil Thematic Strategy gave a further opportunity to European citizens and stakeholders to give their views on the Commission's understanding of the problem of soil loss and soil degradation, and invited submissions on possible solutions, including how the very necessary high level of protection can be given to Europe's soils. Citizens and other stakeholders were also asked to share any relevant information that they may have, including information on possible impacts of the different options available to the Commission in support of the approach and actions that constitute the new EU Soil Strategy, and to expand the knowledge base contained in the Staff Working Document cited above (SWD(2021) 323 final).

Soils are the foundation for 95% of the food we eat, host more than 25% of the world's biodiversity, are the largest terrestrial carbon pool on the planet and play a key role in the circular economy and adaptation to climate change. They are also a finite and non-renewable natural resource. 60-70% of soil ecosystems in

and Social Committee and the Committee of the Regions. SWD(2021) 25 final. Brussels, 24.2.2021.

[11] European Court of Auditors (2018), Special report number 33: Combating desertification in the EU: a growing threat in need of more action.

[12] The European environment — state and outlook 2020: Knowledge for transition to a sustainable Europe. European Environment Agency, 2019.

[13] Commission Staff Working Document accompanying the document "*EU Soil Strategy for 2030 — Reaping the benefits of healthy soils for people, food, nature and climate; Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*". SWD(2021) 323 final. Brussels, 17.11.2021.

the EU are unhealthy and suffering from continuing degradation resulting in reduced provision of ecosystem services.

The European Commission's call for evidence stated that unhealthy soils can be:

i) ***In bad physical condition***:

- ☐ 12.7% of Europe is affected by moderate to high erosion;
- ☐ Between 2012 and 2018, more than 400 km² of land was taken per year in the EU for urban and artificial development on a net basis;
- ☐ More than 530 million tonnes of soil have been excavated and reported as waste; and,
- ☐ An estimated 30 to 50% of the most productive and fertile soils in Europe suffer from soil compaction.

ii) ***In bad chemical condition***:

- ☐ Europe currently exceeds its safe operating space for the nitrogen and phosphorus cycles by factors of 3.3 and 2.0 respectively.
- ☐ Diffuse and local soil contamination is widespread; 390,000 contaminated sites are expected to require remediation; yet, by 2018, only some 65,500 sites were remediated; and,
- ☐ Salinisation affects 3.8 million ha in the EU, with severe soil salinity along the coastlines, particularly in the Mediterranean.

iii) ***In bad biological condition***:

- ☐ Peatland drainage across all land categories in the EU emits around 5% of total EU greenhouse gas emissions; every year mineral soils under cropland are losing around 7.4 million tonnes of carbon.
- ☐ In recent decades, soil biodiversity such as the species richness of earthworms, springtails and mites has been reduced; and,
- ☐ The risk of desertification is increasing across the EU and already affecting agricultural production.

The principal **causes of soil degradation** in the EU are listed as:

- land-use change;
- urban sprawl, excessive and uncompensated spatial development and construction;
- climate change, drought, extreme weather;

- unsustainable soil management and intensification of agricultural and forestry practices;
- industrial activities and emissions, unsustainable waste management and energy production, accidents and spills;
- improper water management, reuse and irrigation; and,
- overexploitation, unmitigated and uncompensated consumption of natural resources.

6.2 Preventing Soil Loss and Soil Degradation

Soil degradation is a wasteful activity that squanders a vital natural resource. Soils provide humans with 98.8% of our food.[14] The human population will likely reach 9.8 billion by 2050; food production will need to rise by 70% from 2005 to 2050 to allow for global food security.[15] Not only are populations increasing, but calorific intake is also rising; daily calorie intake in China in 1963 was 1,400kcal, but stood at 3,100kcal in 2013.

Despite the human population increasing almost three-fold from 1950 to 2015 (2.5 to 7.3 billion people), the proportion of global soil used for cropping increased only slightly from 9.2% to 12.2%. Similarly, cereal production increased almost 400% between 1961 and 2016.[16] Therefore, future food production increases will likely result from further intensification of existing cropland, rather than expansion of land area, though Africa, South America and Asia may see comparatively more cropland expansion. A strategy **to increase food production per hectare** while **conserving and restoring soil health** must be implemented.

Soils also contribute massively to the bioeconomy by providing support and nutrition for plants which give us wood, fibre, raw materials, and food; while soils also provide physical support for infrastructure; regulating services including flood mitigation, filtering of nutrients and contaminants, carbon storage and greenhouse gas regulation, detoxification of wastes, regulation of pests and disease; and cultural services including recreation, aesthetics, heritage values, and cultural identity.[17] By any standard, that is a truly enormous range of bio-services and products, underlining the importance of soil to the bioeconomy.

[14] Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A. and Lombi, E., 2019. Soil and the intensification of agriculture for global food security. Environment international, 132, p.105078.

[15] ELD Initiative, 2015. Report for policy and decision makers: Reaping economic and environmental benefits from sustainable land management. Economics of Land Degradation Initiative, Bonn.

[16] Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A. and Lombi, E., 2019. Cited above.

[17] Dominati, E., Mackay, A., Green, S. and Patterson, M., 2014. A soil change-based methodology for the quantification and valuation of ecosystem services from agro-

The EU currently relies on a conventional agricultural model which is increasingly dependent on imports, has weak food security, is increasingly vulnerable to world market trends and vulnerable to severe environmental degradation.[18] This vulnerability has been emphasised in 2022 by the consequences of the attack by Russia on Ukraine, a country which was for many years described as the "bread basket of Europe".

6.3 Is Agriculture Damaging our Soil ?

The environmentally damaging consequences of the Common Agricultural Policy (CAP) were identified in a report by the European Court of Auditors[19], and summarised by An Taisce:[20]

> *"Despite the vast amounts of EU taxpayers' cash being poured into agriculture, including over €100 billion earmarked to reduce greenhouse gas emissions from the sector in the last seven years, the new report from the European Court of Auditors (ECA) has just confirmed that agricultural emissions have not come down at all since 2010. Indeed, Irish agricultural emissions have actually increased.*
>
> *This, according to the ECA, "is because most measures supported by the Common Agricultural Policy (CAP) have a low climate-mitigation potential, and the CAP does not incentivise the use of effective climate-friendly practices".*
>
> *Livestock emissions account for around half of emissions from agriculture; they have not decreased since 2010, and have risen sharply in Ireland in this period as a result of national government policy.*
>
> *These emissions, the ECA notes, "are directly linked to the size of the livestock herd, and cattle cause two thirds of them. The share of emissions attributable to livestock rises further if the emissions from the production of animal feed (including imports) is taken into account".*
>
> *The report also notes that the CAP supports climate-unfriendly practices, such as paying farmers who cultivate drained peatlands, which represent*

ecosystems: A case study of pastoral agriculture in New Zealand. Ecological Economics, 100, pp.119-129.

[18] Funes-Monzote, F.R., 2009. Agricultura con futuro: la alternativa agroecológica para Cuba. Estación Experimental Indio Hatuey.

[19] European Court of Auditors, 2021. Common Agricultural Policy and climate — Half of EU climate spending but farm emissions are not decreasing, ECA Report No 16, July 2021.

[20] An Taisce Press Release, 23 June, 2021.

less than 2% of EU farmland but which emit 20% of EU agricultural greenhouse gases.

Drainage of peaty lands in Ireland to convert them to grass production to feed livestock is a major additional source of GHG emissions in Ireland. Overall, Ireland's grassland soils are net emitters of approximately 7 million tonnes of CO_2 per annum.

Crucially, the ECA report notes that "EU law does not currently apply a polluter-pays principle to greenhouse gas emissions from agriculture." Were this to change, the highly emissions and pollution-intensive Irish model of concentrating on large-scale dairy and beef production, primarily for export, would be liable to paying for the pollution it creates.

This would likely render much of this sector unviable and calls into question Irish government policies such as Food Harvest 2020, Food Wise 2025 and the upcoming plan for 2030, all of which are predicated on ever-expanding dairy herd numbers".

It is therefore our submission that the agriculture industry, as one of the most important components of Ireland's bioeconomy, must change from the currently exploitative model of "*productivity any cost"*, to a form of agriculture which maintains the health of the soil, through making a transition to organic farming, regenerative farming and other ecologically acceptable practices.

6.4 Can We Feed Ourselves Without Damaging the Soil and its Living Ecosystems

A relevant article in the Irish Times, dated Saturday 12 March 2022, and entitled "*Can Ireland feed itself? Yes. A nutritious diet? Not at the moment"*, stated the situation very well:

"Ukraine is one of the world's major grain exporters. Seeds that were destined for Ukrainian fields sit in warehouses unable to reach farmers and the window to sow them is shortening by the day. Crops already in fields will not be harvested as long as Ukraine is under attack, and some crops may already have been destroyed.

The loss of Ukraine's exports of major agricultural commodities such as wheat, maize, and sunflower oil, along with the loss of fertiliser supplies from Russia, has serious repercussions for global agriculture and food supplies".[21]

[21] *Can Ireland feed itself? Yes. A nutritious diet? Not at the moment*. Ruth Hegarty; Irish Times, Saturday 12 March 2022 (https://www.irishtimes.com/life-and-style/food-and-drink/can-ireland-feed-itself-yes-a- nutritious-diet-not-at-the-moment).

A further problem is that agricultural intensification, through increased chemical use and homogenization of landscapes, is a major cause of biodiversity loss.[22]

In Ireland, a number of major soil health related issues are beginning to impact negatively on cropland productivity, net carbon emissions, water quality, ecosystem services and biodiversity, unless action is taken quickly. These issues include:

1. Soil erosion;
2. Loss of soils through urban sprawl;
3. Excavation and disposal of soils as waste;
4. Soil compaction;
5. Nitrogen and phosphorus overload, leaching into water bodies;
6. Soil contamination;
7. Peatland drainage; and,
8. Biodiversity decline.

Nearly three years ago, in May 2020, Ireland's largest and most influential environmental NGO, and a member of the European Environment Bureau, wrote that:

> *"Nature has been thrown a lifeline by the EU Commission, with the publication of its landmark 'Farm to Fork' and Biodiversity strategies. An Taisce commends the Commission's newly confirmed 2030 targets, which include:*
>
> - ✓ *Reduction by 50% in overall use of – and risk from – chemical pesticides by 2030 and reduce by 50% the use of more hazardous pesticides by 2030.*
> - ✓ *The reduction of the use of fertilisers by at least 20%.*
> - ✓ *At least 10% of agricultural area to be under high-diversity landscape features.*
> - ✓ *At least 25% of agricultural land to be under organic farming management, and the uptake of agro-ecological practices to be significantly increased.*
>
> *Taken together, these reforms will have far-reaching implications, with nature and biodiversity the biggest winners. Farmers too will see wide-ranging*

[22] Tscharntke, T., Grass, I., Wanger, T.C., Westphal, C. and Batáry, P., 2021. Beyond organic farming–harnessing biodiversity-friendly landscapes. Trends in Ecology & Evolution, 36(10), pp.919-930.

benefits, with diversification and soil fertility being supported and protected by the new measures.

For Ireland, the requirement to transition to at least 25% of our farmland to organic systems promises the greatest revolution in farming methods in the modern era. Ireland currently has among the very lowest percentage of farmland managed organically in the EU, at around 2% of total land.

This will mean increasing our acreage farmed organically at least 10-fold in the coming decade. This will be challenging and will need to be supported financially, but presents a unique opportunity for the 'green' rhetoric in our agrifood sector to become a reality.

Reform of the Common Agriculture Policy (CAP) to focus on true sustainability and the achievement of ambitious climate goals is essential to ensure that EU taxpayers' money is directed towards forms of agriculture that work with nature and respect and protect biodiversity.

For too long, agricultural policy at EU level has been driven by the interests of multinational agrichemical and agrifood corporations, keen to profit from industrialising the countryside and with scant regard for the devastating consequences of the use and overuse of chemical pesticides, herbicides and fertilisers.

The growing dependency of many farmers on these extremely expensive and ecologically damaging inputs needs to be sharply reversed while the key EU goal of its agricultural systems underpinning food security across the continent is met.

It is ironic indeed that despite Ireland's 'Origin Green' marketing campaign, the EU Commission roadmap is in fact pointing in exactly the opposite direction to the past 10 years of Ireland's agriculture strategies, written by food processors and rubber-stamped by politicians. These have disproportionately benefited the mega landowners and have intensified chemical usage, water, air and climate pollution impacts, and biodiversity losses.

An Taisce also warmly welcomes the Commission's commitment to carrying out a review of the EU promotion programme for agricultural products, with a view to enhancing its contribution to sustainable production and consumption, and in line with the evolving diets.

We also welcome the EU's commitment to promoting more sustainable farming and fisheries practices, reducing deforestation, enhancing biodiversity, and improving food security and nutrition outcomes with its global trading partners.

Good quality food, safely and sustainably produced, is the keystone for longer term European prosperity and resilience in the face of the rapidly growing threat of climate change and biodiversity collapse. The EU Commission has taken an important step toward this goal".

This positive critique of the European Commission's **Farm to Fork** and **Biodiversity** strategies summarises our own response to the proposed Bioeconomy Action Plan.

An earlier report by James O'Donovan, entitled "*Transition to an Irish Vegan Agricultural System"*,[23] highlights major inefficiencies in the global agricultural system, in which 77% of total agricultural land is used to support livestock, producing only 18% of the global calorie supply.

This excellent and very detailed report advocates a transition from meat and dairy production in Ireland to a vegan agricultural system, pointing out that in Ireland (2019), 97% of agricultural land is used for meat and dairy production. In the EU, in 2019, between 69% (€28.5 billion) and 79% (€32.6 billion) of the Common Agricultural Policy (CAP) direct payments were for livestock rearing.

This important report recommends that all small farms should be converted from animal agriculture to payment for ecosystem services, in total 43,600 small farms. This would potentially free up 0.46 Mha of land for restoration of native forestry, grasslands and wetlands; and these recommendations, if implemented, would directly benefit soil health, and would ensure that agriculture can make a positive contribution to the bioeconomy.

James O'Donovan's report concludes that:

"The most effective way for agriculture to change will come from changes in consumer behaviour supported by legal and policy supports for plant based agriculture from national governments and Global Agreements. In Europe and Ireland the CAP needs to change to stop subsidising meat and dairy production and instead support ecosystem services or plant based agricultural systems. A transition to a vegan agricultural system will enable us to:

- ✓ *stop agriculture from consuming more forests, grasslands and other ecosystems;*
- ✓ *eliminate pesticides and antibiotics from agriculture;*
- ✓ *gradually restore ecosystems and biodiversity and thereby reverse climate change;*

[23] James O'Donovan, 2019. "Transition to an Irish Vegan Agricultural System". 96pp.

- ✓ *boost the productivity of farms as plant based agriculture is much more efficient;*
- ✓ *raise the efficiency of water and fertiliser use worldwide;*
- ✓ *reduce waste in food production and distribution as grains and legumes are much easier to store without deterioration.*

Globally switching to a whole food plant based diet has the potential to return millions of acres of land to wild habitat, to reverse rainforest destruction, to restore the health and volume of our freshwater rivers and lakes, to prevent further species extinctions, to eliminate billions of tons of pollutants (cow dung, carbon dioxide, methane, nitrous oxides, and ammonia), and to make a major contribution to stabilising and reversing climate change. Gradually as people become conscious of the ethical, environ- mental, economic, and health benefits then they will find the motivation to choose a plant based diet. When this happens is up to all of us. The faster we transition to a non-violent VAS (Vegan Agricultural System) the faster we can stem the haemorrhage of biodiversity loss and restore our health and the health of the planetary systems we depend on".

This report on the transformation of Irish agriculture summarises very well our own view of the situation and what should be done at European level to create and implement the necessary changes to a more sustainable form of agriculture which would include a high level of soil protection. We briefly describe some of these changes in section 6.6 below.

6.5 A Healthy Diet for a Healthy Planet

In January 2019, the EAT–Lancet Commission published an authoritative report on "*Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems".* The report could best be described as a healthy diet for a healthy planet, and was the subject of much discussion, including unfavourable criticism from organisations with an interest in maintaining the environmentally damaging form of industrial food production which has caused huge biodiversity loss and soil damage.

The report provides much evidence that, while food production systems have the potential to nurture human health and support environmental sustainability, our current food production trajectories threaten both. The EAT–Lancet Commission addresses the need to feed a growing global population a healthy diet while also defining sustainable food systems that will minimise damage to our planet.

The Commission quantitatively describes a universal healthy reference diet, based on an increase in consumption of healthy foods (such as vegetables, fruits, whole grains, legumes, and nuts), and a decrease in consumption of unhealthy foods (such as red meat, sugar, and refined grains) that would provide major

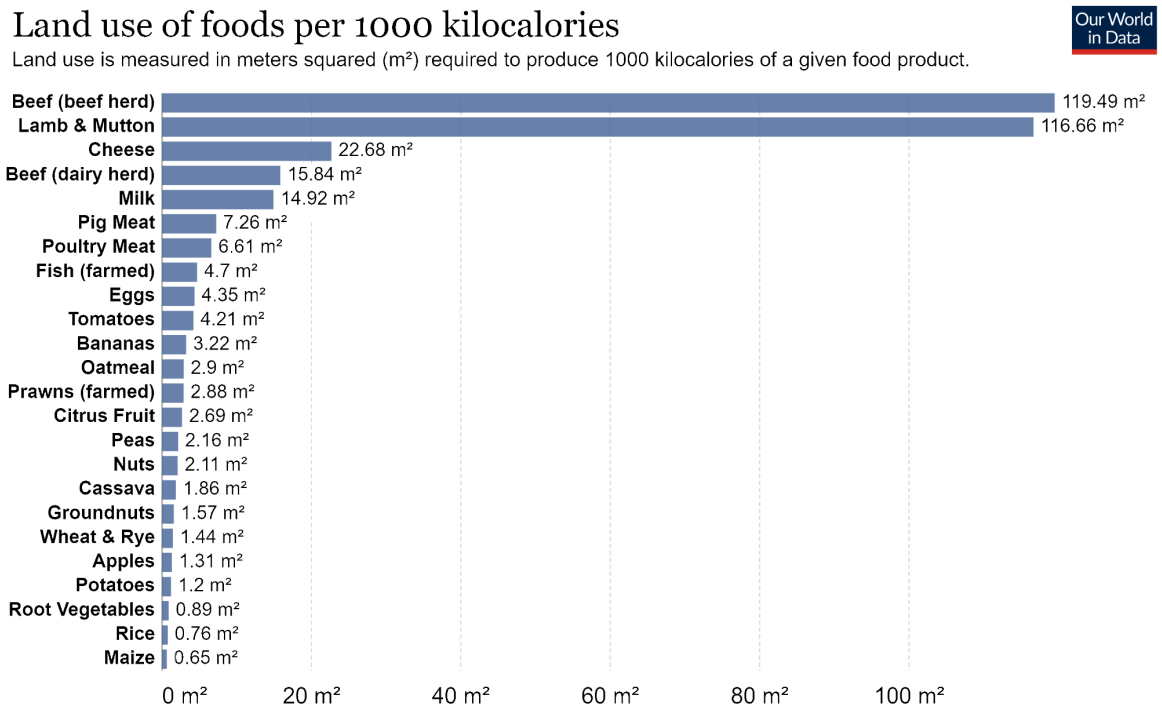
health benefits, and also increase the likelihood of attainment of the Sustainable Development Goals. This is set against the backdrop of defined scientific boundaries that would ensure a safe operating space within six Earth systems, towards sustaining a healthy planet.

The Lancet Commission identified food production as the largest pressure caused by humans on the environment, and recommended major changes to diets necessary to avoid reduced life expectancy and environmental degradation, including soil degradation. The dietary recommendations call for a **plant-based diet** consisting mostly of fruit, vegetables, whole grains, legumes, nuts, and unsaturated oils, a low to moderate amount of seafood and poultry, and **no or a low quantity of red meat, processed meat, added sugar, refined grains, and starchy vegetables**. The Lancet Commission showed that it is possible to feed a global population of nearly 10 billion people a healthy diet within the recommended food production boundaries by 2050. Food for these 10 billion humans must be provided **using no additional land**.

Crop plants can provide a multitude of raw materials, biomass, food and metabolites for medicine and industry. Implementing sustainable ecological agricultural practices can reduce negative environmental impacts while maintaining high yields for the growing global population. **The reduction of animal rearing for meat is key.** Although some cropland expansion is caused by farmers growing food for direct human consumption, livestock rearing, including feed production, accounts for approximately 75% of all agricultural land and nearly 33% of the ice-free land surface of the planet, making it the single largest land use type.[24]

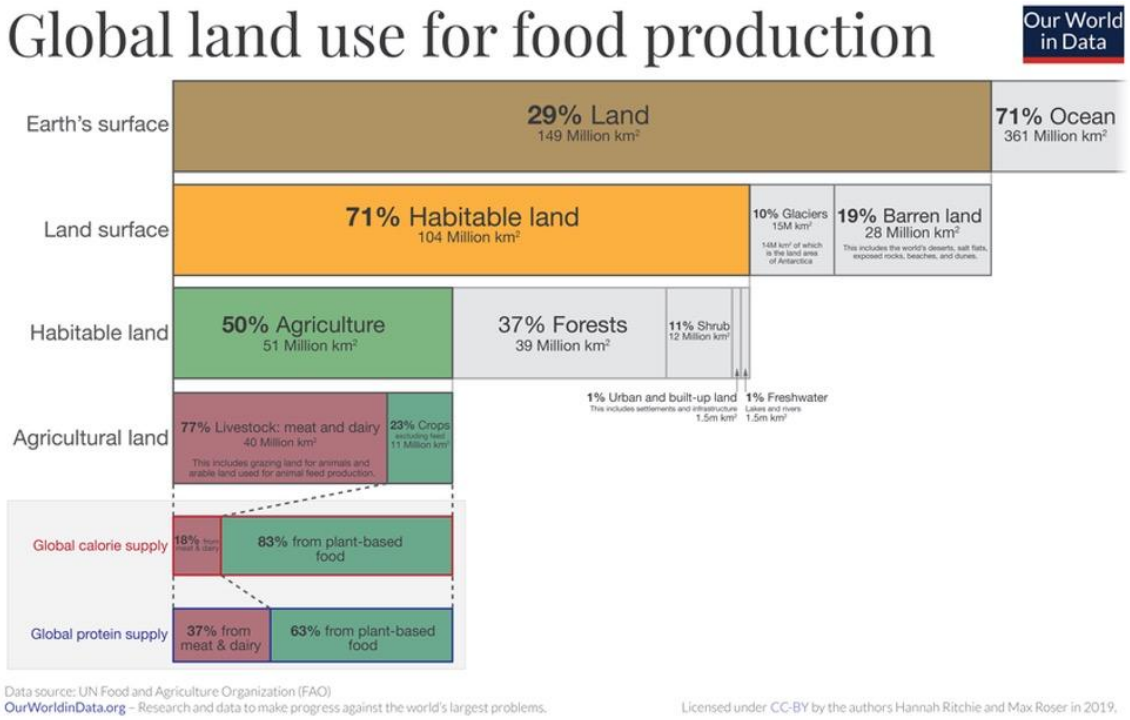
In the graph below (on the next page), note the large land area required to produce 1,000 calories from beef herds. Though beef is very calorie-dense as a food product, many more people can be fed with one acre of peas or wheat, for example, than one acre land for beef production. One reason for this is the requirement for land for cereal production (i.e., barley) to help feed cattle. **Therefore, converting beef production land to vegetable or cereal production will free up large areas of land, while still feeding the existing human population.** This newly available land can be used for re-wilding and mixed forestry plantations to support biodiversity, produce sustainable building materials, sequester carbon in soils or produce biofuels. This extra land could be a key foundation of the sustainable bioeconomy.

[24] Steinfeld, H., Gerber, P., Wassenaar, T.D., Castel, V., Rosales, M., Rosales, M. and de Haan, C., 2006. Livestock's long shadow: environmental issues and options. Food & Agriculture Org..



Currently the human population is 7.9 billion. Replacing meat and dairy production with plant-based food production would result in less cropland required for the **same total calorie production**, while freeing up a significant proportion of global agricultural land.

This extra land could instead be converted to natural or semi-natural habitats to support soil health, carbon sequestration and biodiversity. The establishment of field margins through EU incentives may be a practical strategy to help achieve this. In Ireland, replacement of meat and dairy agricultural land with forest could help achieve the aims of the EU Green Deal targets for 2030, Farm to Fork strategy and EU Biodiversity Strategy. Increasing the grand available to farmers in Ireland for agroforestry may also be an economically sound method of converting intensive cropland to biodiverse, high production, semi-natural farmland.



Source: Our World In Data. Note the large proportion (77%) of land devoted to producing just 18% of global calorie supply.

It is our submission and recommendation that implementation of the following key messages from the EAT–Lancet Commission report would benefit not only people, human health and ecosystems, but would also benefit the soil globally, as more land could be released from intensive production of meat.

> *"1. Unhealthy and unsustainably produced food poses a global risk to people and the planet. More than 820 million people have insufficient food and many more consume an unhealthy diet that contributes to premature death and morbidity. Moreover, global food production is the largest pressure caused by humans on Earth, threatening local ecosystems and the stability of the Earth system.*
>
> *2. Current dietary trends, combined with projected population growth to about 10 billion by 2050, will exacerbate risks to people and planet. The global burden of non-communicable diseases is predicted to worsen and the effects of food production on greenhouse-gas emissions, nitrogen and phosphorus pollution, biodiversity loss, and water and land use will reduce the stability of the Earth system.*
>
> *3. Transformation to healthy diets from sustainable food systems is necessary to achieve the UN Sustainable Development Goals and the Paris Agreement, and scientific targets for healthy diets and*

sustainable food production are needed to guide a Great Food Transformation.

4. *Healthy diets have an appropriate caloric intake and consist of a diversity of plant-based foods, low amounts of animal source foods, unsaturated rather than saturated fats, and small amounts of refined grains, highly processed foods, and added sugars.*

5. *Transformation to healthy diets by 2050 will require substantial dietary shifts, including a greater than 50% reduction in global consumption of unhealthy foods, such as red meat and sugar, and a greater than 100% increase in consumption of healthy foods, such as nuts, fruits, vegetables, and legumes. However, the changes needed differ greatly by region.*

6. *Dietary changes from current diets to healthy diets are likely to substantially benefit human health, averting about 10·8–11·6 million deaths per year, a reduction of 19·0–23·6%.*

7. *With food production causing major global environmental risks, sustainable food production needs to operate within the safe operating space for food systems at all scales on Earth. Therefore, sustainable food production for about 10 billion people should use no additional land, safeguard existing biodiversity, reduce consumptive water use and manage water responsibly, substantially reduce nitrogen and phosphorus pollution, produce zero carbon dioxide emissions, and cause no further increase in methane and nitrous oxide emissions.*

8. *Transformation to sustainable food production by 2050 will require at least a 75% reduction of yield gaps, global redistribution of nitrogen and phosphorus fertiliser use, recycling of phosphorus, radical improvements in efficiency of fertiliser and water use, rapid implementation of agricultural mitigation options to reduce greenhouse-gas emissions, adoption of land management practices that shift agriculture from a carbon source to sink, and a fundamental shift in production priorities.*

9. *The scientific targets for healthy diets from sustainable food systems are intertwined with all UN Sustainable Development Goals. For example, achieving these targets will depend on providing high-quality primary health care that integrates family planning and education on healthy diets. These targets and the Sustainable Development Goals on freshwater, climate, land, oceans, and biodiversity will be achieved through strong commitment to global partnerships and actions.*

> 10. *Achieving healthy diets from sustainable food systems for everyone will require substantial shifts towards healthy dietary patterns, large reductions in food losses and waste, and major improvements in food production practices. This universal goal for all humans is within reach but will require adoption of scientific targets by all sectors to stimulate a range of actions from individuals and organisations working in all sectors and at all scales."*

If we take into account the importance of food production as a component of the bioeconomy, and the need to produce food without destroying the environment (including the soil), we can clearly see the need for close collaboration between agriculture, the food industry, the promotion of human health, and other aspects of the bioeconomy. As we stated in our introduction, all of these activities and issues are inter-related and linked, and must be addressed comprehensively to avoid the current crises becoming more damaging and serious.

6.6 Changing Our Farming Practices

The report by James O'Donovan quoted above recommended that the most effective way for agriculture to change will come from changes in consumer behaviour supported by legal and policy supports for plant based agriculture.[25]

But there are other, and perhaps easier, ways we can change, and in the following sections we will briefly describe these, as pointers to how agriculture may become more sustainable, and may make a more positive and beneficial contribution to Ireland's bioeconomy.

Farming is the cultivation of living matter, raised to serve as food or consumable items for humans. Although agriculture has its own role in our communities, landscape, food production and impacts on biodiversity – 64% of the nation of Ireland is used for farmland – a plan for nature must be embedded into standard agricultural practices. There are many ways the industry could become a national mechanism for climate change mitigation and circularity. For example, mixed rotational farming and improving the soil structure through root diversity has a positive impact on prevention of run off, and the health of the soil ecosystem.

6.6.1 Mixed Crop Rotation

Mixed rotation is a farming practice that increases the depth and diversity of root structure in the soil, particularly when crop selections encourage competition driving the roots of both species further into the ground. When the crop is harvested or removed – the decomposing organic matter of the previous crop

[25] James O'Donovan, 2019. "Transition to an Irish Vegan Agricultural System". 96pp.

opens up the soil, making it more porous, feeding the soil biodiversity and leaving available nutrients for the next crop that would be sown.

A paper by Woźniak et al., (2019)[26] outlined the advantages of crop rotation versus spring barley monocultures. The rotation sequence was: peas – spring barley – winter wheat, while the cereal monoculture was: spring barley – winter wheat – winter wheat. There are clear economic and environmental benefits to crop rotation. Higher barley grain yield was recorded, with associated higher profits. Grain yield in crop rotation systems was recorded as 25.6% higher than in cereal monoculture. Plants make better use of the available nutrients in soil when grown in rotation. Weeds, pathogens, and pests are less prevalent due to the host crops changing year by year.

According to Woźniak and Soroka (2015)[31] and Shahzad *et al*., (2016)[27] cereal monoculture leads to increased infestation with weeds and, consequently, a decrease in yield. Weeds which are highly competitive with the host cereal will become pervasive and persistent in the soil. This requires heavy application of herbicide to control, which negatively impacts soil health and biodiversity, and cuts into potential profits.

As we mentioned very briefly in section 5.3 above, a resurgence of sugar beet production in Ireland would present an opportunity to establish good rotational practices to maximise soil health and profitability.

The benefits of mixed rotation are easily understood in the farming community because it would have been the common practice until specialisation became mainstream in recent decades. Maintaining the soil carbon without further disturbance and embracing practices including cover cropping, min till and incorporation of a humus layer on the soil surface instead of bare soil are all practices we incorporate with success.

6.6.2 No-Till Cultivation

The technique of "no-till" has demonstrated clear benefits in specific soil health markers including organic matter, active carbon, respiration, and protein content. Four physical soil indicators also showed improvements: available water capacity, water stable aggregation, penetration resistance and water infiltration rate. Additionally, soil chemical indicators were improved: plant available nutrients, pH and total nitrogen. Increased corn yields were recorded in silt loam and a loamy sand soil,

[26] WOŹNIAK A., SOROKA M. Structure of weed communities occurring in crop rotation and monoculture of cereals. International Journal of Plant Production, 9 (3), 487, 2015.

[27] SHAHZAD M., FAROOQ M., JABRAN K., HUSSAIN M. Impact of different crop rotations and tillage systems on weed infestation and productivity of bread wheat. Crop Protection, 89, 161, 2016.

6.6.3 Perennial Crops

Efforts are underway to develop perennial versions of grain crops, such as intermediate wheatgrass, (*Thinopyrum intermedium*). A study by Daelemans *et al*., (2022)[28] concluded that perennial crops are a viable alternative to annual crops since perennial systems have long-lasting and extensive root networks, minimising soil health degradation. Therefore, they help reduce wasteful erosion and nutrient leaching from soil.

Current global food security mainly relies on annual grains — cereals, oilseeds, and legumes — planted on almost 70% of croplands, which combined supply a similar portion of human calories.

These crops grow for one season and must be re-sown year after year. Perennial grain crops, however, remain for 2 years or more and can develop much more extensive root systems. Kreitzman *et al.,* (2020)[29] have shown that perennial crops make up a small, significant (4.5%), but a growing portion of global cropland. Their paper emphasises the high productivity of some perennial crops, meaning that a transition from annual crops may not entail yield losses in some regions.

If land under perennial crops were to increase in a linear fashion, 956 million tons of carbon (MtC) could be sequestered by the year 2040, with associated soil health benefits. Alfalfa is an example of a useful perennial crop which is nitrogen fixing, can be cut or grazed for animal feed and produces edible seed. Other perennial crops include kale, asparagus, rhubarb, oil palm and fruit and nut trees.

6.6.4 Intercropping

Intercropping is a common practice in organic farming, where alternatives to chemical fertilisers have been sought.

Jensen *et al*., (2020)[30] analysed the intercropping of legumes and cereals. Increased Nitrogen-use efficiency was noted in intercropping systems, leading to a theoretical reduction in fossil-based nitrogen fertiliser use by 26% on a global scale. The study suggests intercropping has advantages including increased yield stability and yield per unit area, reduced pests, reduced agrochemical demand and improved soil biodiversity. However, challenges still exist in

[28] Daelemans, R., Hulsmans, E. and Honnay, O., 2022. Both organic and integrated pest management of apple orchards maintain soil health as compared to a semi-natural reference system. Journal of environmental management, 303, p.114191.

[29] Kreitzman, M., Toensmeier, E., Chan, K., Smukler, S. and Ramankutty, N., 2020. Perennial staple crops: yields, distribution, and nutrition in the global food system. Frontiers in Sustainable Food Systems, p.216.

[30] Jensen, E.S., Carlsson, G. and Hauggaard-Nielsen, H., 2020. Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis. Agronomy for Sustainable Development, 40(1), pp.1-9.

harvesting the mixed crops, further study and funding by the EU may help solve this.

Romaneckas *et al*., (2020)[31] designed an experiment to investigate the effect of intercropping sugar beet with clover, barley, and ambient weeds as a green manure. Under minimal fertilisation, soil nitrogen, phosphorous and potassium increased, while sulphur was decreased. Sugar beet yield was significantly decreased, while the quality was unchanged. These results show the necessity for further study into intercropping to maintain high yield, improve soil health while decreasing dependence on fertilisers.

6.6.5 Cover Crops

The EU Soil Health Directive highlights the need for "*measures that can contribute to reducing nutrient losses by at least 50% without deterioration in soil fertility (resulting in the reduction of fertiliser use by at least 20%".* Implementation of cover crops is one such measure; they can reduce runoff volume, sediment loss, and nitrate leaching, but may have smaller effects on reducing dissolved nutrients in runoff.[32]

Cover crops generally do not compete with the main crop for resources and they also help to keep down weeds.[33] Cover crops with fibrous root systems are especially effective in halting soil erosion.[34] Cottney et al., (2021)[35] investigated the integration of cover crops in arable systems in Ireland. The cover crops were grown over winter to improve sustainability, instead of leaving the land fallow. In the Republic of Ireland, subsidisation is available to farmers for cover cropping, but not in the North of Ireland. These two regions of Ireland are in close proximity geographically, being part of the one country under different jurisdictions; therefore the subsidisation scheme in the Republic of Ireland most likely plays a major role in influencing how and why cover crops are used.

In the North of Ireland, 54% of farmers have planted cover crops before compared to a higher proportion of 77% in the Republic of Ireland . This demonstrates the

[31] Romaneckas, K., Adamavičienė, A., Šarauskis, E. and Balandaitė, J., 2020. The impact of intercropping on soil fertility and sugar beet productivity. Agronomy, 10(9), p.1406.

[32] Blanco-Canqui, H., 2018. Cover crops and water quality. Agronomy Journal, 110(5), pp.1633-1647.

[33] Sharma, P., Singh, A., Kahlon, C.S., Brar, A.S., Grover, K.K., Dia, M. and Steiner, R.L., 2018. The role of cover crops towards sustainable soil health and agriculture—A review paper. American Journal of Plant Sciences, 9(9), pp.1935-1951.

[34] De Baets, S., Poesen, J., Meersmans, J. and Serlet, L., 2011. Cover crops and their erosion-reducing effects during concentrated flow erosion. Catena, 85(3), pp.237-244.

[35] Cottney, P., Williams, P.N., White, E. and Black, L., 2021. The perception and use of cover crops within the island of Ireland. Annals of Applied Biology, 179(1), pp.34-47.

higher rate of and increased willingness to plant cover crops in the Republic of Ireland, possibly because of a better awareness and level of agricultural training.

6.6.6 Agroecological Crop Protection (ACP)

Agroecological Crop Protection (ACP), closely allied to ecologically aware farming and regenerative farming, is the innovative application of agroecology to crop protection, and is built on two foundations: biodiversity and soil health, in order to make agroecosystem less susceptible to biotic stresses, for example herbivorous insects and weeds.[36]

The concept of Integrated Pest Management was popular in the 1980s and 1990s. It treated insect populations as allies or enemies, to be controlled with combined chemical and biological methods, with the aim of minimising damage to the ecological environment. A new paradigm shift of emphasising the importance of the farm as part of a **functioning ecosystem** has since been gaining momentum. The application of ACP has the potential to improve soil health by encouraging ecosystem friendly practices, while reducing chemical control methods. A reduction of pesticides, herbicides and fungicides is correlated with higher soil biodiversity and soil health markers.

The use of broad-spectrum herbicides to control weeds is prevalent in Ireland. Glyphosate is also used to stop the growth of barley, and to dry it out for more efficient harvesting.[37] Additional glyphosate applications to fields after barley harvesting removes the wild plant cover that otherwise would provide protection from water and wind erosion. With frequent annual use, residual concentrations of glyphosate in soil builds up and persists. Only about 5% of the applied dose reaches the target weed, while the remainder contacts the soil surface, affects the roots of plants intercepting the glyphosate, or is released from plant tissues upon decomposition.[38]

Excessive use of herbicide is wasteful and leads to soil degradation and erosion, as well as serious biodiversity damage and loss, and has no place in environmentally and socially sustainable agriculture.

[36] Deguine, J.P., Aubertot, J.N., Flor, R.J., Lescourret, F., Wyckhuys, K.A. and Ratnadass, A., 2021. Integrated pest management: good intentions, hard realities. A review. Agronomy for Sustainable Development, 41(3), pp.1-35.

[37] Roseboro, K., "Why Is Glyphoste Sprayed On Crops Right Before Harvest?" Mar. 5, 2016, Ecowatch.

[38] Kremer, R., Means, N. and Kim, S., 2005. Glyphosate affects soybean root exudation and rhizosphere micro-organisms. International Journal of Environmental Analytical Chemistry, 85(15), pp.1165-1174.

6.6.7 Agroforestry & Tree Planting

In 2015, Ireland had the second lowest percentage tree cover in the EU at 11.03%, and was ranked 144th out of 189 countries globally (FAO, 2015). The report by O'Donovan cited earlier in this submission recommended that farmers in Ireland should be paid to convert 1.7 Mha of land to native broadleaf forests to reach the European average of 34% (2.5 Mha) forest cover. A study by Wang et al., (2020) in Northern China found that reforestation is an effective method for preventing water and wind erosion of soil, and the total erosion reduction has a linear relation to the increase of forest land area.

Jalón *et al*., (2018)[39] conducted a case study on a silvo-arable experimental plot of poplar trees planted in 1992 in Bedfordshire, Eastern England. Compared to a regular arable system, soil erosion loss in the silvo-arable system was reduced by about 50%. The authors expect the reduction would be even greater on sloped ground.

A study by Ruseva *et al*., (2015)[40] found that financial incentives were successful in increasing tree planting by landowners. This is promising for the implementation of other soil health management strategies, and we strongly recommend that improved financial incentives should be available for farmers who adopt agro-ecological soil protection practices.

6.6.8 Organic Farming

Organic farming is widely believed to be the only alternative to intensive farming for protecting soil health and biodiversity. Organic agriculture provides roughly a 30% increase in species richness, at the cost of considerable yield losses. To feed the world's population using only organic agriculture, more land would have to be converted to cropland, destroying valuable ecological habitats in the process. Therefore, a viable alternative is required.

6.6.9 Field Margins

One possibility is to reduce the size of fields currently under intensive agriculture, while establishing strips of semi-natural habitat on the periphery. Semi-natural habitats have much greater ecological functioning than even organic cropland. De Cauwer *et al.*, (2006)[41] measured decreased nitrogen pollution of ground-

[39] García de Jalón, S., Graves, A., Palma, J.H., Williams, A., Upson, M. and Burgess, P.J., 2018. Modelling and valuing the environmental impacts of arable, forestry and agroforestry systems: a case study. Agroforestry systems, 92(4), pp.1059-1073.

[40] Ruseva, T.B., Evans, T.P. and Fischer, B.C., 2015. Can incentives make a difference? Assessing the effects of policy tools for encouraging tree-planting on private lands. Journal of Environmental Management, 155, pp.162-170.

[41] De Cauwer, B., Reheul, D., Nijs, I. and Milbau, A., 2006. Effect of margin strips on soil mineral nitrogen and plant biodiversity. Agronomy for sustainable development, 26(2), pp.117-126.

water and increased plant biodiversity after establishing grass/forb margins in arable fields after 5 years. A width of 5 metres was recommended. Semi-natural grasslands provide many ecosystem functions including **protection of soils from erosion, protection of soil biodiversity, regulation of water quality, nutrient cycling, reduction of groundwater nitrogen and CO_2 sequestration**[42],[43]. Therefore, one of our recommendations in this submission is that improved subsidies should be given to farmers, to encourage them to establish semi-natural margins in arable land to help minimise the wasteful deterioration of soil and water.

Grass margins were proposed in many European countries in response to arable land degradation. When grass margins are implemented in adjacent fields, wildlife corridors are created. A conserved lattice of natural or semi-natural land will promote wildlife and plant movement to maintain genetic and population vigour, recolonize connected habitats after local extinction, and allow migration in response to climate change.[44] Soil bacterial and fungal diversity increases after conversion of cropland to grassland, peaking after 30 years.[45] High crop yields can be maintained in the arable field while promoting biodiversity at the margins. Crop diversification, smaller fields, and establishment of semi-natural habitat patches can have greater positive effects on biodiversity than organic certification[46].

6.7 Forestry and Land Use

6.7.1 Forestry

The generation of woody biomass from forestry is a promising approach for sustainable raw materials for the bioeconomy, while providing an opportunity for carbon sequestration. **However, the proliferation of monoculture forest plantations must be avoided to protect the key elements of the biosphere mentioned above.** Forest biodiversity must be maintained and increased over

[42] Ferrarini, A., Serra, P., Almagro, M., Trevisan, M. and Amaducci, S., 2017. Multiple ecosystem services provision and biomass logistics management in bioenergy buffers: A state-of-the-art review. Renewable and Sustainable Energy Reviews, 73, pp.277-290.

[43] Hopkins, A., 2009, May. Relevance and functionality of semi-natural grassland in Europe–status quo and future prospective. In International workshop of the SALVERE-Project (pp. 9-14).

[44] Resasco, J., 2019. Meta-analysis on a decade of testing corridor efficacy: what new have we learned?. Current Landscape Ecology Reports, 4(3), pp.61-69.

[45] Yang, Y., Li, T., Wang, Y., Dou, Y., Cheng, H., Liu, L. and An, S., 2021. Linkage between soil ectoenzyme stoichiometry ratios and microbial diversity following the conversion of cropland into grassland. Agriculture, Ecosystems & Environment, 314, p.107418.

[46] Sirami, C., Gross, N., Baillod, A.B., Bertrand, C., Carrié, R., Hass, A., Henckel, L., Miguet, P., Vuillot, C., Alignier, A. and Girard, J., 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions. Proceedings of the National Academy of Sciences, 116(33), pp.16442-16447.

the coming century to provide goods and services to the growing human population and to halt the biodiversity crisis.[47] In 2015, Ireland had the second lowest percentage tree cover in the EU at 11.03%, and was ranked 144th out of 189 countries globally (FAO 2015). 8 years later, total forest cover in Ireland is currently only at 11.6%, compared to an average 40% across Europe.

Previously, plantation forests were considered "green deserts" with no ecological value. It is now widely accepted that plantation forests can support biodiversity to some degree.[48] However, primary native forests and mixed species plantations are always superior in terms of biodiversity. Mixed native tree plantations can be sensibly managed to maintain biodiversity of wildlife and soil health, while maintaining high yield.

An experimental mixed species plantation with Norway spruce *(Picea abies*), Scots pine (*Pinus sylvestris*), sessile oak (*Quercus petraea*), Sitka spruce (*Picea sitchensis*) and common alder (*Alnus glutinosa*) was established in England. Greater height and diameter growth was observed in the mixed plots, with some combinations resulting in 40% greater growth versus monoculture.[49]

Trees planted in Ireland from the early 20th century to the present day have been mostly Sitka spruce (*Picea sitchensis)*, and Douglas-fir (*Pseudotsuga menziesii*), both introduced from the Pacific coast region of North America. In its natural habitat, Sitka Spruce can live for 700 years and can attain great heights of almost 100m. In its natural range, the trees support biodiversity by providing food for deer (tender spring shoots) and shelter (particularly the oldest trees). The rough bark also provides a habitat for mosses and lichens. However, Sitka spruce is commonly planted in Ireland and elsewhere in Europe in dense monoculture plantations, where all trees are the same age and little to no ground vegetation can survive. 33% of European forests are composed of monoculture stands,[50] roughly 52 million hectares.

This type of land-use is highly wasteful since the opportunities for valuable ecosystem services are missed. Note that no greenhouse gas (GHG) or global

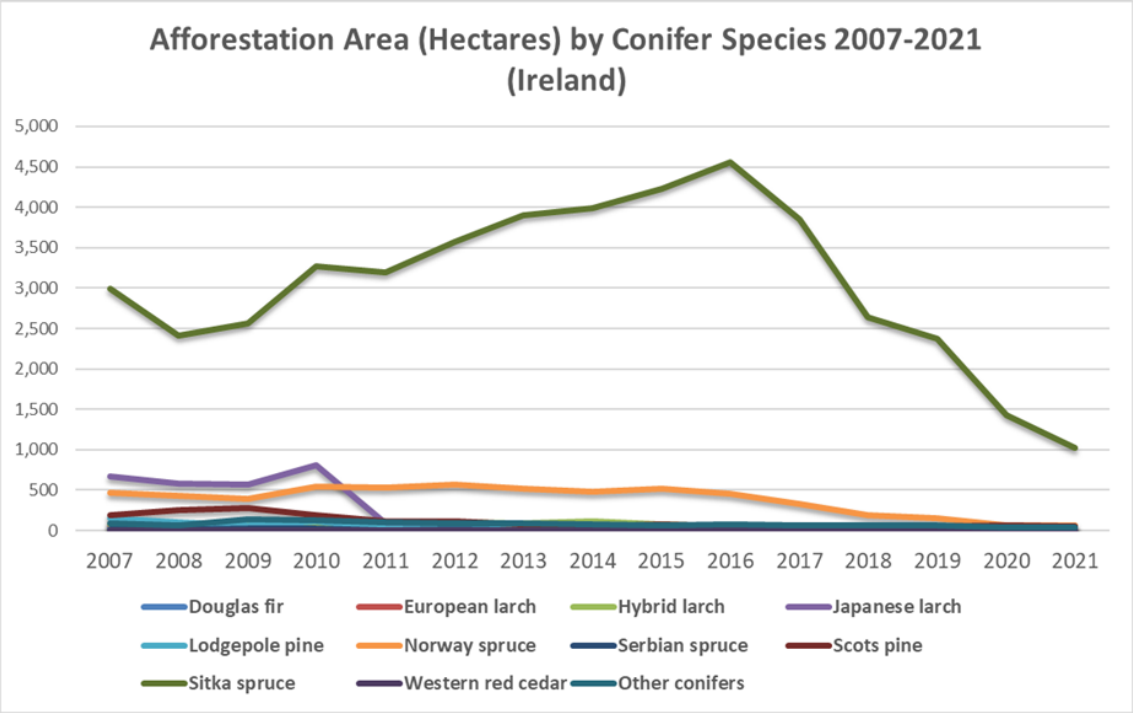
[47] Watson, R., Baste, I., Larigauderie, A., Leadley, P., Pascual, U., Baptiste, B., Demissew, S., Dziba, L., Erpul, G., Fazel, A. and Fischer, M., 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat: Bonn, Germany, pp.22-47.

[48] Bremer, L.L. and Farley, K.A., 2010. Does plantation forestry restore biodiversity or create green deserts? A synthesis of the effects of land-use transitions on plant species richness. Biodiversity and Conservation, 19, pp.3893-3915.

[49] Mason, W.L. and Connolly, T., 2014. Mixtures with spruce species can be more productive than monocultures: evidence from the Gisburn experiment in Britain. Forestry, 87(2), pp.209-217.

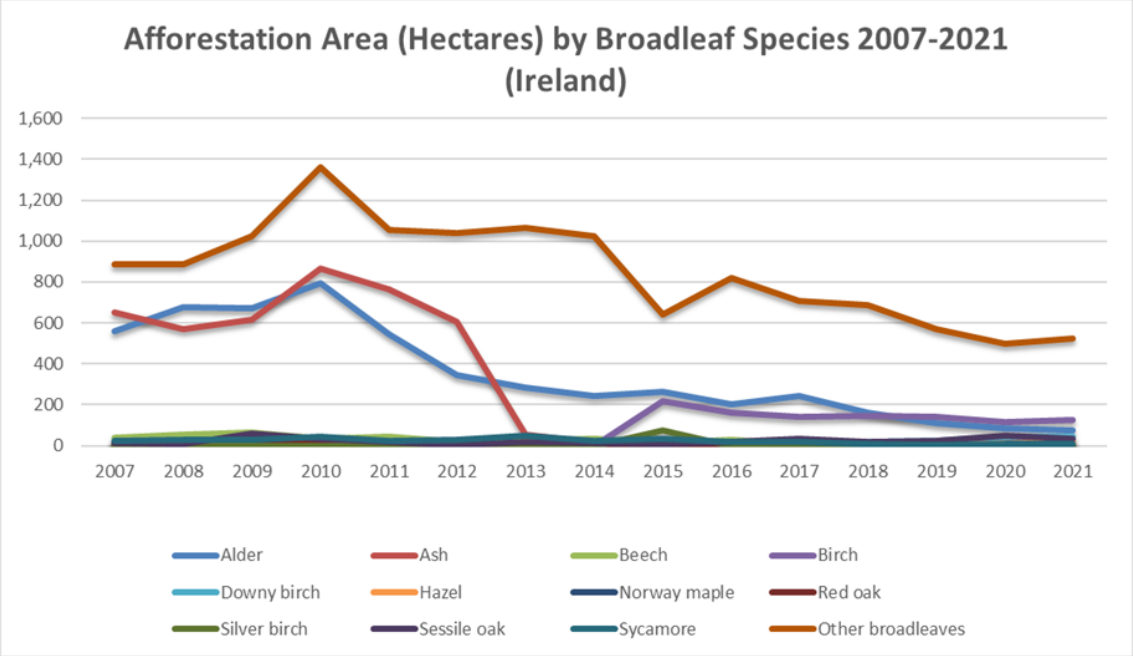
[50] State of Europe's Forests 2020, FOREST EUROPE, https://foresteurope.org/wpcontent/uploads/2016/08/SoEF_2020.pdf (Accessed January 2023)

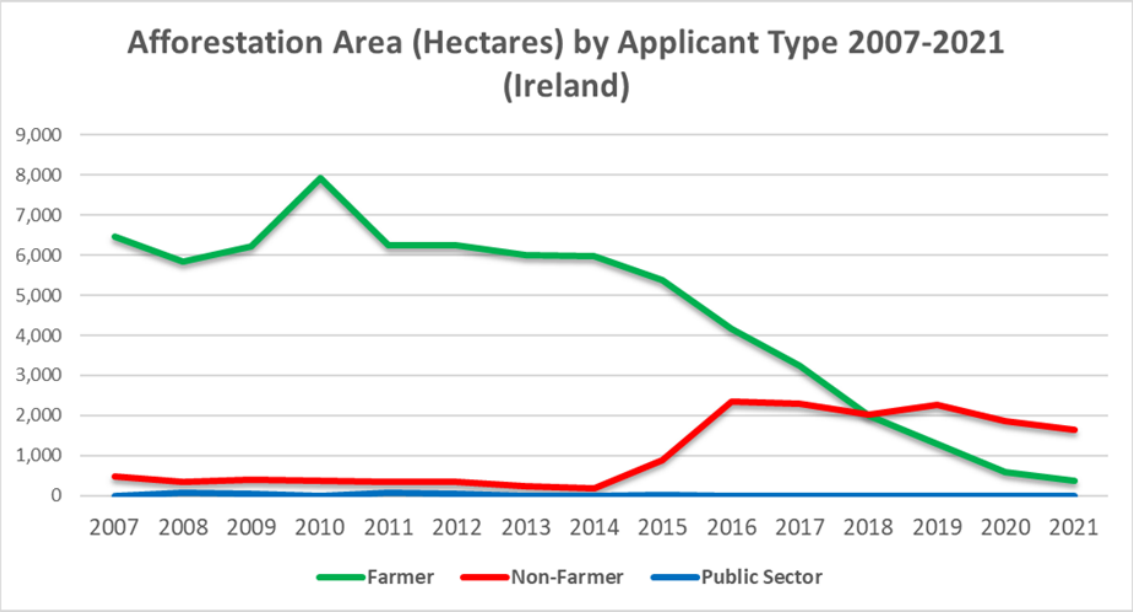
warming potential (GWP) life cycle assessment has been performed on the production and distribution of Medium Density Fibreboard (MDF) made from Sitka spruce in Ireland.



This data from the Central Statistics Office (CSO) on afforestation (planting of new forests) of conifer species shows a trend towards **decreasing species diversity** beginning in 2011. The vast majority of conifers planted in Ireland after this date were Sitka spruce and Norway spruce. From 2016 onwards the total afforestation began to decline every year until 2021.

The data on broadleaf afforestation above again shows a trend of decreasing species diversity and an overall decrease in total afforestation area each year until 2021. Note also that "other broadleaves" was the largest category of trees planted in 2021 yet the species that make up this category was not revealed. Ash trees (*Fraxinus excelsior*) were not allowed to be planted due to the spread of ash dieback disease from 2013, caused by the fungus *Hymenoscyphus fraxineus*.





The data on afforestation area by applicant type shows, beginning in 2014, a clear and dramatic decrease in applications for the forestry grant by farmers and an increase in applications by non-farmers (private land-owners and corporations). The cause of this shift was the introduction of a new forestry grant scheme in 2014, the "Afforestation Grant and Premium Scheme 2014-2020".[51]

[51] Afforestation Grant and Premium Scheme 2014-2020

This forestry act failed on most of its objectives. It failed to increase forest cover in Ireland past 11% and did not increase the biodiversity of new forests. As is clear from the above graphs, new plantations from 2011 onwards had decreased diversity.

The reaction to the forestry act is reflected in this article by the Irish Examiner in November 2013.[52] The article, which was informed by Co. Cavan Teagasc forestry development officer Kevin O'Connell, encouraged farmers to plant Sitka spruce for "big money" pointing out that broadleaves take much longer to grow. Agroforestry may provide a solution to the low rates of afforestation in Ireland.

Forestry and water quality have had an unhappy relationship in Ireland for many years, primarily as a result of the dense planting of coniferous species on upland sites, with resulting acidification of downstream watercourses. Clear felling of plantations, the construction of forest roads and the movement of heavy vehicles have also resulted in ecological damage to surface waters.

We would additionally suggest that forestry in Ireland must move from being a fast-growing timber production activity, to becoming a longer-term land use based on slower-growing native species which can provide better quality timber, habitats for improved biodiversity, and better protection of quality in woodland streams and rivers. This will require a change of mindset, not only among the timber producers, but also in the regulatory agencies, especially the Department of Agriculture, Food and the Marine (DAFM). The employment of an additional significant number of ecologists by the DAFM, and the increased engagement of consultant ecologists by Registered Foresters when developing projects, is already helping this process.

However, one cautionary note must be added – for many years the state forestry operation (Coillte) has relied on spraying significant quantities of toxic biocides (insecticides, herbicides and fungicides) in forest planting and management. These biocides have the potential to contaminate streams and rivers, and to damage aquatic species and biodiversity; and it is quite likely that elevated concentrations of these toxicants are present in these watercourses. Monitoring of such streams, especially those in remote upland areas which serve as catchments for public or private water supplies, is essential. In addition, forestry practice must also be encouraged to change, away from the single-minded production of timber (often of low quality) to agro-forestry and the delivery of water-related ecosystem services including water purification, flood control, biodiversity and carbon capture.

[52] Much to consider in planting a forest

6.7.2 Land Use Planning and the Bioeconomy

One of the most important points we wish to make is that land use planning is a key issue in any bioeconomy action plan, as the land is the foundation of so much of the bioeconomy; and, if we want to expand the bioeconomy (as recommended in the Department's consultation document) this will likely lead to competition for the use of land, for example, competition between using land for wildlife (rewilding), for forestry, for food growing, recreation, amenity, and biodiversity, etc.

Therefore all bioeconomy management issues should be addressed on an integrated land and water management framework which takes into account the way in which land is used and managed, how those land uses affect water quality and aquatic ecosystems, and how water (in every form) dominates and affects actual and potential land uses.

According to the Food and Agriculture Organisation of the United Nations (FAO), the ecosystems which provide the foundation for sustainable agriculture in productive landscapes are being degraded, their integrity disrupted at unprecedented rates, and the natural resource base of soils, water, land, and ecosystems upon which food production depends is under stress, degraded, or already significantly depleted.[53]

A paper published a few years ago provides the following comment on the need for an integrated land-use strategic framework which, we would argue, must also include protection, management and conservation of water resources:

> *"Sustainable land management is at the heart of some of the most intractable challenges facing humanity in the 21st century. It is critical for tackling biodiversity loss, land degradation, climate change and the decline of ecosystem services. It underpins food production, livelihoods, dietary health, social equity, climate change adaptation, and many other outcomes. However, interdependencies, trade-offs, time lags, and non-linear responses make it difficult to predict the combined effects of land management decisions. Policy decisions also have to be made in the context of conflicting interests, values and power dynamics of those living on the land and those affected by the consequences of land use decisions. This makes designing and coordinating effective land management policies and programmes highly challenging. The difficulty is exacerbated by the scarcity of*

[53] Landscapes for Life – Approaches to Landscape Management for Sustainable Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome, 2017.

reliable data on the impacts of land management on the environment …" [54]

Landscape and territorial approaches that focus on people and their aspirations are among the most effective ways to address development needs while restoring and protecting natural resources. The rationale for applying integrated approaches at landscape scale is three-fold: landscapes offer a platform that is comprehensive in scope across sectors and domains, addressing issues at their appropriate scale, and thereby improving the likelihood of project success and sustainable outcomes.

The methodology used by the FAO is through watershed management, similar to river basin management, and is one of the more traditional and recognized approaches utilised throughout the world. This approach has a long history of addressing complex problems and providing solutions to support integration and collaboration across sectors, scales and actors, balance competing needs to generate simultaneous benefits for people and environment. It follows the principles of common concern, multiple scales, multifunctionality and multi-stakeholders.

But ZWAI is advocating that the proposed new Bioeconomy Action Plan should address not only the management of land, water and biological resources as the most important resources which maintain our bioeconomy, but should follow the **principle of multifunctionality**, to provide both environmentally and socially sustainable management of a wide range of ecosystem services and goods, such as fresh water, timber, agricultural crops, other types of human and animal foods, fibres and useful plant species, together with protection and enhancement of terrestrial and aquatic biodiversity, water storage, support for nutrient cycling, regulation of water flows, mitigation of climate change effects, and protection of air quality.

It is clear to us that such a multi-faceted approach will need far more inter-agency and inter-departmental cooperation than exists at present in Ireland (and more than appears in the Departments' "Consultation Document on the Bioeconomy"), but there are no legal or administrative barriers to such integration, and many benefits – both environmental and socio-economic.

These benefits are derived from strengthening the interlinkages between biodiversity, ecosystem services, agriculture and water resource management through practices such as:

[54] McGonigle D.F., Rota Nodari G., Phillips R.L., Aynekulu E., Estrada-Carmona N., Jones S.K., Koziell I., Luedeling E., Remans R., Shepherd K., Wiberg D., Whitney C., and Zhang W. (2020). A Knowledge Brokering Framework for Integrated Landscape Management. Front. Sustain. Food Syst. 4:13. doi: 10.3389/fsufs.2020.00013.

- forest restoration and sustainable forest management which will support air and water purification, carbon sequestration and storage;
- sustainably managed agricultural lands, forests and watercourses which will reduce risks and damage from floods, storms, bogslides (peat slides) and droughts;
- sustainable land management practices and properly managed permanent vegetation cover, which will promote nitrogen fixation processes and will strongly contribute to combating soil erosion and soil loss, maintaining soil health and fertility, and reducing the quantities of silt entering streams and rivers;
- sustainable livestock grazing, which will support balanced ecological mosaics, ecosystem diversity, nutrient cycling, and the dispersal of seeds, and will also support resilience, primary productivity, and protection from pests and diseases; and,
- integration of fisheries enhancement and maintenance, which will support good management of watercourses and water bodies, primary productivity in freshwater ecosystems, protection from waterborne pests and diseases, nutrient cycling and water purification.

An integrated land and water management framework would take into account the way in which land is used and managed, how those land uses affect water quality and aquatic ecosystems, and how water (in every form) dominates and affects actual and potential land uses:

> *"Sustainable land management is at the heart of some of the most intractable challenges facing humanity in the 21st century. It is critical for tackling biodiversity loss, land degradation, climate change and the decline of ecosystem services".*[55]

The viewpoint which we are advocating is supported by the key messages from a recent report by the European Environment Agency:[56]

- ✓ *Managing natural resources has historically focused on individual resources and value chain-based approaches. While these provide valuable insights, wider systems thinking is needed to address the complex interactions between different natural resources. For example,*

[55] McGonigle D.F., Rota Nodari G., Phillips R.L., Aynekulu E., Estrada-Carmona N., Jones S.K., Koziell I., Luedeling E., Remans R., Shepherd K., Wiberg D., Whitney C., and Zhang W. (2020). A Knowledge Brokering Framework for Integrated Landscape Management. Front. Sustain. Food Syst. 4:13. doi: 10.3389/fsufs.2020.00013.

[56] Resource nexus and the European Green Deal, EEA Briefing Number 24-2021, published 17-Mar-2022.

the links between food, energy and water resources point to the need for such a systems approach.

- ✓ *The **resource nexus** concept fulfils this need, as it specifically looks at resource interlinkages. Applying it to policy interventions generates important information about synergies and trade-offs across several resource-related goals as a contribution to more effective management strategies.*

- ✓ *The findings of three case studies on organic farming, advanced biofuels and electric vehicles point to the usefulness of the approach for identifying knowledge gaps, imbalances in policy focus, potential "winners and losers", and as a basis for informed discussions.*

- ✓ *Resource nexus assessments add to the systemic understanding of sustainability challenges and responses. Combined with other tools and frameworks, e.g. foresight and governance approaches, they could effectively support the European Green Deal's ambitions of strengthening policy coherence and integration.*

The concept of the "*resource nexus"* was first introduced in 2011, to address key interdependencies among resources and their use, and it has since gained prominence in the international research community and among international organisations operating at the science-policy interface.

The Food and Agriculture Organization of the United Nations defines the resource nexus as a "*conceptual approach to better understand and systematically analyse the interactions between the natural environment and human activities, and to work towards a more coordinated management and use of natural resources across sectors and scales"*.[57]

While early applications focused on exploring the interlinkages between water, energy and food, further developments embraced other natural resources, including land, materials, waste and ecosystems, and other dimensions such as climate and health. Collating these applications results in a complex web of direct and indirect interactions, which define the 'nexus' among the resources. Understanding this network of interactions provides important information, as a given intervention might have different effects across resources – positive or negative – depending on the way they interact. For example, demand for food can be met through various agricultural practices that may require different levels of land, energy, water and other inputs, and the same is true for demands on other resources.

[57] FAO, 2014, The water-energy-food nexus. A new approach in support of food security and sustainable agriculture, Food and Agriculture Organization of the United Nations, Rome, Italy.

It is clear to see that in Ireland this concept has not been adopted or applied, despite what we would suggest is an urgent need for this type of systematic and integrative approach.

In Ireland, the planning system has failed to provide any kind of sustainable or integrated land and water management approach; planning matters are highly centralised, with local authorities being subject to strict rules laid down by the Department of Housing, Planning and Local Government and (more recently) by the Office of the Planning Regulator. While these rules may be intended to prevent the type of "developer-led" planning which has so undermined good planning in Ireland, they have also had the effect of reducing local democratic involvement in planning.

A further problem is caused by the almost complete lack of integration between planning for settlements (town planning), rural planning generally, agricultural planning, and policies for other land uses such as forestry, industry, transportation, inland fisheries, and amenity uses of public forests, and of inland and coastal waters. Policies and objectives affecting these land uses are split between departments and agencies which frequently hold conflicting views, and which rarely take into account land or water uses other than those for which a particular department or agency is responsible.

It is therefore one of our key recommendations that the new Bioeconomy Action Plan 2023-2025 should be based on integrated land and water management, using the 'nexus' approach and framework described above, taking into account the way in which land is used and managed; and how land uses and water resources interact with each other. This approach also requires new legislation and an appropriately designed management structure.

7. SEAS, OCEANS AND THE MARINE BIOECONOMY

Water is not mentioned in the Department's consultation document, and wastewater is mentioned only once, in section 6.6 on page 15.

The failure to mention water is a serious omission, given the importance of our streams, rivers and lakes to the bio-economy, through fisheries for example (commercial eel fishing, freshwater aquaculture and recreational angling); and if we consider that these features of the environment, including their living components such as freshwater plants, give so much enjoyment and contribute to human well-being, they should be included.

The "Marine Bioeconomy", otherwise called the "Blue Bioeconomy" poses a contribution toward combating climate change and is an important factor worth considering within the bioeconomy. The development of new or underutilised marine biomass resources is an important alternative which significantly interests

scientist's today. The wild harvesting and mariculture of low-trophic non-fed species of marine biomass could sufficiently help the circular economy model toward combating climate change.

It is a true fact that the failure to reduce waste, recycle and repair, yet the re-usage clearly proves that the current modern extraction of more raw materials, along with their transportation and process, toward manufacturing the materials and goods which we have discarded, leads to the usage of more energy than the one produced by recycling or reusing.

The circular economy, though, is, by its nature, well-organised and energy-saving.

To begin with, it is worth pointing out the meaning of the term Marine or Blue Bio-economy. The "blue bio-economy" includes fish (demersal and pelagic) shellfish, seaweed and plankton (on which many larger species depend), and immobile organisms such as coral reefs. The fish, shellfish and seaweed may be wild populations or may be cultured and harvested under human control. Therefore, the Blue Bio-economy provides food, and raw materials, such as alginates and other products from seaweed. What is more, it is worth mentioning that the living oceans themselves are helping to mitigate the worst effects of climate change by absorbing enormous amounts of carbon dioxide generated by human activity. Marine and aquatic research and innovation are, undoubtedly, essential to explore the best ways for the ocean to continue to be a healthy and productive life support system.

It is clear that human activity currently takes too much biomass from the sea and it is widely known that in terms of marine ecosystem protection, very large fishing vessels use electronic aids and powerful engines, enabling fish stocks to be exploited to a point beyond sustainability. As over 3.2 billion people rely on it as 20% of their protein intake, it is highly important to underline alternative ways of measuring the environmental impact of the fishing industry. Many of the practices and methods of the commercial fishing industry also threaten ocean environments, such as trawling, in which a net is dragged along the ocean floor, and fishing gear that is disposed of within our oceans. These practices disturb the bottom of the seabed by dragging up plants and coral populations that provide vital importance for maintaining the balance of marine ecosystems.

The United Nations estimates that 95% of global ocean damage is a direct result of bottom trawling and Greenpeace found that 640,000 tons of fishing gear account for the waste in our oceans each year, which is the equivalent of the weight of 50 thousand double-decker buses, while local or artisanal fisheries do not cause this kind of extensive damage. Human encroachment has destroyed more than 35% of mangroves, 30% of seagrass meadows and 20% of salt marshes.

The damage to the oceans and the constant pollution of the water, along with the threat of extinction to some populations of fish, triggers an urgent need to develop the Blue Bio-economy.

7.1 The Importance of Marine Algae; a Carbon Sink and Ecosystem Engineer

Studies reveal that seaweed, with the exception of kelp forests which should be protected, could play a significant part in developing Marine Bioeconomy as this kind of productive ecosystem can sequester high scales of carbon dioxide, decreasing its emissions, up to five times that stored in tropical forests.

To be more specific, research shows that the microalgae culture offers an interesting step for wastewater treatments since they provide a third-stage biotreatment coupled with the production of potentially valuable biomass, which can be used for several purposes.

Particularly, a paper published in 2016 in Nature Geosciences provides an estimate of how much atmospheric carbon is being removed by macroalgae. According to the data provided by the research, around 200 million tons of carbon dioxide are being sequestered by macroalgae every year – about as much as the annual emissions of the state of New York.

Additionally, marine macroalgae are considered to be an excellent natural biosource in different aspects of agricultural fields, as they serve proficiency in improving the physical and chemical properties of soil. They also produce a large array of biologically active biocidal substances against plant-infecting pathogens.

When considering the improvement of the numbers on how much carbon is being sequestered by macroalgae, human activities need to measure how much macroalgae ends up in the deep sea. It has been proved that as macroalgae groups slowly degrade, they expel bits of DNA into the environment. Research groups are planning on experimentally measuring the proportions of macroalgae that get buried each year by taking samples from the deep sea and measuring the amount of macroalgal DNA. Through this operation, they found that seaweed debris was an important part of the food web for marine organisms and that much of that debris was ultimately stored in sediments or entered the food web on the seafloor.

Carbon sequestration is necessary to slow climate change, ad hoc, but it cannot solely prevent climate emergencies without fossil fuels reduction. Studies highlight the importance of protecting valuable marine ecosystems such as kelp forests from environmental damage. The prime reason is the fact that carbon sinks such as kelp forests would play a key role in reaching net zero emissions if decreasing the use of fossil fuels.

On 03 June 2019, Florida State University researchers found that researchers suspected that the high productivity and huge amount of seasonal biomass of annual algae would provide carbon subsidies farther offshore than typically considered. Moreover, according to the European Commission, algae are gaining widespread recognition in Europe as an important resource as a raw material for a wide range of uses and there are 9 EU-funded projects that are investigating industrial processes and applications involving microalgae and seaweed. Those results could contribute to an actual plan for the "Blue Bioeconomy".

Uses vary for marine algae to be used as a nutraceutical, as an organic sunscreen, for fertiliser and for treating wastewater.

7.2. The Importance of Kelp Forests for Marine Ecosystems; Current Trends in Unsustainable Kelp Harvesting

Ayr-based Marine Biopolymers (MBL) is a company based in Scotland, who were sponsored by Zero Waste Scotland, to extract valuable polymers from kelp harvested in Scottish waters. The material could, theoretically, replace some single use plastics and contribute to the circular economy. However, as mentioned above, kelp forests support diverse assemblages of marine species, therefore community-wide disruption can be expected after harvesting.[58] Kelp forests act as ecosystem engineers[59] by altering sedimentation, light levels, physical scour and waterflow. They provide a structural habitat and food for a significant part of the marine food web upon which we depend for many commercially important species.[60] A study on the biodiversity of *Laminaria hyperborea* off the coast of Norway discovered that on average, a single kelp plant can support about 40 macroinvertebrate species represented by almost 8000 individuals.[61] As discussed above, kelp forests capture atmospheric carbon dissolved in seawater and are therefore an important carbon sink.[62] Industrial dredging/harvesting of kelp is damaging to marine ecosystems: mechanical

[58] Carbajal, P., Gamarra Salazar, A., Moore, P.J. and Pérez-Matus, A., 2022. Different kelp species support unique macroinvertebrate assemblages, suggesting the potential community-wide impacts of kelp harvesting along the Humboldt current system. Aquatic Conservation: Marine and Freshwater Ecosystems, 32(1), pp.14-27.

[59] Samson, F.B., Knopf, F.L., Jones, C.G., Lawton, J.H. and Shachak, M., 1996. Organisms as ecosystem engineers. Ecosystem management: selected readings, pp.130-147.

[60] Smale, D.A., Burrows, M.T., Moore, P., O'Connor, N. and Hawkins, S.J., 2013. Threats and knowledge gaps for ecosystem services provided by kelp forests: a northeast Atlantic perspective. Ecology and evolution, 3(11), pp.4016-4038.

[61] Christie, H., Jørgensen, N.M., Norderhaug, K.M. and Waage-Nielsen, E., 2003. Species distribution and habitat exploitation of fauna associated with kelp (Laminaria hyperborea) along the Norwegian coast. Journal of the Marine Biological Association of the United Kingdom, 83(4), pp.687-699.

[62] Krumhansl, K. and R. E. Scheibling. 2012. Production and fate of kelp detritus. Mar. Ecol. Prog. Ser. 467:281–302.

harvest of kelp forests resulted in 90% decrease in small gadid fish and a decrease in cormorant feeding efficiency,[63] likely due to decreased fish abundance. Mechanical harvesting of kelp every 5 years in Norway allowed the recruitment and regrowth of the plants, but the species assemblages did not fully recover before the next harvest.[64] The Scottish government moved to ban kelp dredging in November 2018.[65]

This is an example of biological technologies being used for private profit with little or no regard for environmental and ecological consequences. Suitable rocky reef habitat is found along much of the coastline of Ireland, especially the South, West and North coasts. We have the opportunity to learn from these events in Scotland to avoid environmental destruction in the development of the bioeconomy in Ireland. **It is our submission that the tenets of ecosystem and habitat protection must be foundational to the bioeconomy**.

7.3 Seaweed Farming

The only sustainable option for marine biomass production is the cultivation of seaweeds in otherwise barren coastal areas. The establishment of seaweed farms may lead to biodiversity enrichment by providing food and shelter for marine species where little existed before.[66] Researchers from Trinity College Dublin have recommended seaweed farming as a sustainable method of carbon sequestration: "blue carbon".[67] Cultivated seaweed can also provide valuable polymers and feedstock for biofuels.[68]

However, the consequences of extensive seaweed cultivation on existing marine communities and nutrient cycling are not well understood,[69] wide-scale seaweed farming may lead to reduced nutrient levels in water, resulting in reduced production in the seabed and pelagic layer, altering species community

[63] Lorentsen, S.H., Sjøtun, K. and Grémillet, D., 2010. Multi-trophic consequences of kelp harvest. Biological Conservation, 143(9), pp.2054-2062.

[64] Christie, H., Fredriksen, S. and Rinde, E., 1998. Regrowth of kelp and colonization of epiphyte and fauna community after kelp trawling at the coast of Norway. In Recruitment, Colonization and Physical-Chemical Forcing in Marine Biological Systems (pp. 49-58). Springer, Dordrecht.

[65] https://scottishwildlifetrust.org.uk/news/kelp-dredging-banned-in-scotland/

[66] Radulovich, R., Umanzor, S., Cabrera, R. and Mata, R., 2015. Tropical seaweeds for human food, their cultivation and its effect on biodiversity enrichment. Aquaculture, 436, pp.40-46.

[67] Dolliver, J.P., 2022. Evaluating the status and prospects of blue carbon in Ireland and the North-East Atlantic (Doctoral dissertation, Trinity College Dublin. School of Natural Sciences. Discipline of Zoology).

[68] Laurens, L.M., Lane, M. and Nelson, R.S., 2020. Sustainable seaweed biotechnology solutions for carbon capture, composition, and deconstruction. *Trends in Biotechnology*, *38*(11), pp.1232-1244.

[69] Aldridge, J., van der Molen, J. and Forster, R., 2012. Wider ecological implications of macroalgae cultivation. The Crown Estate, 95.

structures. If damage to existing marine habitats can be avoided, ZWAI recommends government to subsidise farmed seaweed to incentivise farmers and entrepreneurs to develop the macroalgae industry sustainably.[70]

7.4 No-Catch Zones

Implementing no-catch zones can have long term positive ecological and economic benefits.[71] Closing areas of marine territory to fishing allows fish stocks to recover. This is known as the "reserve population". These no-catch zones then resupply normal fishing zones by the movement and migration of fish, or "spillover". The spillover effect results in higher productivity and profits than before. In New Zealand, a no-catch zone allowed 'spill-over' of lobsters to counter-balance lost fishing.[72] Surprisingly, closing areas of low productivity to fishing can be economically profitable when the spillover effect generates more value than actually fishing the low productivity area. No-catch zones can synergise with other no-catch zones by the ecological connectivity effect. When species (i.e. fish) can move freely between habitats, the abundance and diversity of each connected habitat increases.[73] Therefore, by connecting several no-catch zones and allowing fish to migrate between them, total profits and total biodiversity will increase.

It is our recommendation that ecologically connected no catch zones should be implemented immediately for the benefit of marine biodiversity and the competitiveness of the blue bioeconomy.

8. THE BIOECONOMY AND CLIMATE CHANGE

Our planet is currently facing multiple challenges and our dependence on finite resources has resulted in greenhouse gas emissions, in turn resulting in climate change which is threatening our survival and biodiversity. The bioeconomy allows the potential for new research and innovation, for finding new renewable raw materials and for the production of alternative goods and services. Mitigating climate change is essential and moving away from the use of fossil fuels is key to this.

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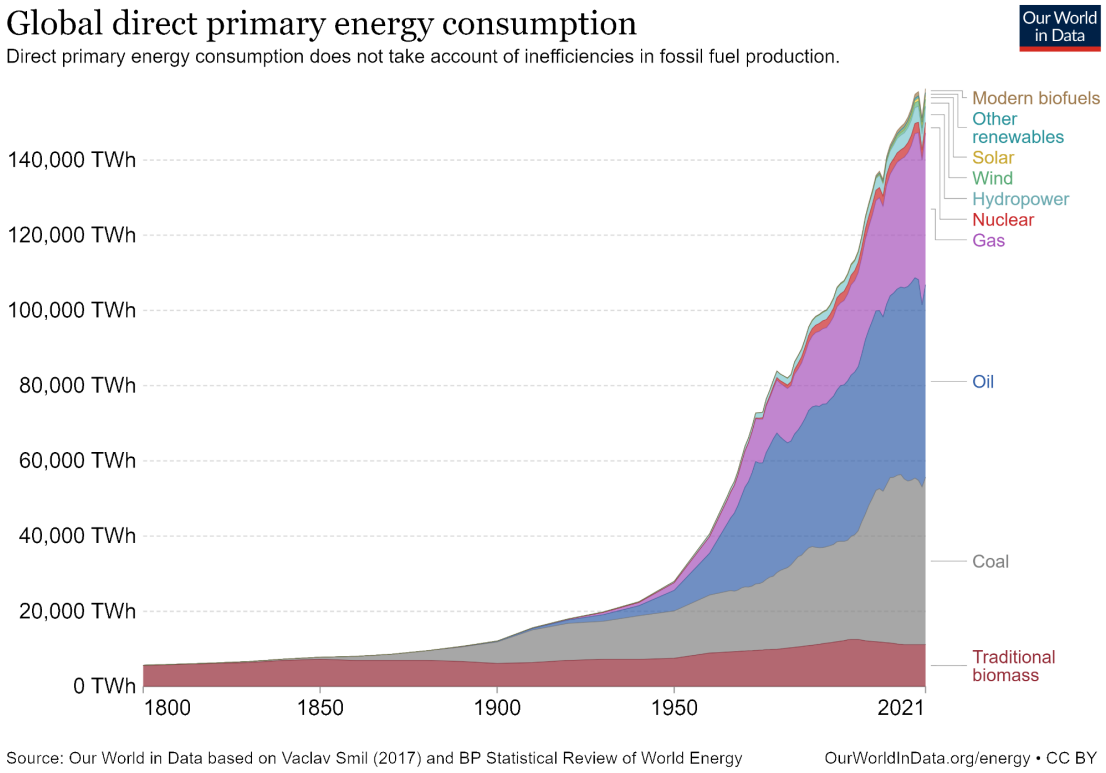
[70] Monagail, M.M. and Morrison, L., 2020. The seaweed resources of Ireland: a twenty-first century perspective. Journal of applied psychology, 32(2), pp.1287-1300.

[71] Sanchirico, J.N., Malvadkar, U., Hastings, A. and Wilen, J.E., 2006. When are no-take zones an economically optimal fishery management strategy?. Ecological Applications, 16(5), pp.1643-1659.

[72] Costello, M.J., 2014. Long live Marine Reserves: A review of experiences and benefits. Biological Conservation, 176, pp.289-296.

[73] Olds, A.D., Connolly, R.M., Pitt, K.A. and Maxwell, P.S., 2012. Habitat connectivity improves reserve performance. Conservation Letters, 5(1), pp.56-63.



Global energy consumption has increased almost exponentially, driven by new technologies beginning in the industrial revolution in the 1760s. Note the tiny fraction of energy provided by renewables including modern biofuels, solar, wind and hydropower in the above graph. These disruptive technologies have the potential to replace fossil fuels, though they must be scaled up massively to achieve this goal. The elimination of fossil fuel use is essential to stop runaway climate change.

8.1 First Generation Biofuels

In the quest to find an alternative fuel source in the transition away from fossil fuels, first generation biofuels were developed using energy rich food crops such as oilseed rape, corn and sugarcane. Starch and sugar are fermented into bioethanol and oil-rich plants are used to produce biodiesel. However, crops grown for biofuel production compete for agricultural land with regular food crops, leading to the "food vs fuel" competition. Due to the growing human population and increasing costs of fertilisers this model is impractical.

8.2 Second Generation Biofuels

Woody plant material containing cellulose and lignin like *Miscanthus*, straw, hemp, willow and forestry leftovers could be used to generate ethanol for fuel. Refineries to convert cellulose to ethanol are currently being developed, though the valorisation of lignin proves to be more challenging. Some biomass can be produced on marginal land, but in general these types of crops require large

areas of farmland that is needed for food production, again sparking the "food vs fuel" debate.

8.3 Third Generation Biofuels

Algae and microalgae are being considered for renewable energy as an economically viable option. Microalgae in particular are promising due to the wide range of valuable co-products that can be produced in the generation of biofuels. Microalgae can be cultivated in biorefineries, on dry land, on waste ground, deserts, and other such areas, so they will not compete for space with food crops. Microalgae photosynthesise just like plants, releasing oxygen and accumulating sugars inside the cells. Some species can accumulate long-chain fatty acids that can be converted to biodiesel. The cells also produce high value substances including proteins, enzymes, vitamins, antioxidants, pigments and fatty acids for pharmaceutical production. Wastewater and sewage can be used as a renewable source of nutrients for microalgae growth. Microalgae should not be overlooked as a sustainable source of renewable materials to drive the competitiveness of the bioeconomy.

9. The Essential Role of Circularity – Making the Bioeconomy Circular in Action

Enacted globally, a circular economy can close the "Emissions Gap". By combining the twin agendas of the circular economy and climate mitigation, Ireland can more easily become a leader on the path to a well below 2-degree world by 2032, and thus a leader in the bioeconomy.

In developing and adopting a roadmap with detailed and comprehensive "whole-of-Government" circular economy strategies, we can lead the way for the systemic transformations needed to course-correct the global economy.

Unfortunately, the major problem is that circularity in our world is trending downwards, not upwards. While the Circularity Gap Report 2020 revealed that the global economy was only 8.6% circular, just two years earlier it was 9.1%. So, although we only need to almost double circularity to close the Emissions Gap by 2032, the world remains shackled by outdated 'take-make-waste' practices.

Humanity has now also breached two major milestones: the world is consuming 100 billion tonnes (Gt) of materials and it has become at least 1°C warmer. All indicators point to the reality that the world remains engulfed by the linear economy and its unsustainable practices, processes and behaviours. However, when the Covid-19 pandemic swept the world in 2020, we saw in Ireland nearly empty skies and roads, as our entire population was placed under national lockdown. Temporary as the resulting drop in annual global emissions was, it

highlighted what is possible: from governments to citizens, we are now armed with the knowledge that transformational change is doable.

Reducing Ireland's "Circularity Gap" can be achieved by implementing a circular economy which can satisfy societal needs and wants by doing more with less. We need materials to fuel our lifestyles; the production of these produces emissions.

Therefore, to be truly sustainable and competitive, the bioeconomy must be circular. Because the bioeconomy is based on living organisms and systems, it must reflect nature in its structure. Nature is circular in the sense that all organic matter is decomposed and recycled by fungi and other soil organisms. Likewise, the materials used in the bioeconomy must be re-used and recycled through composting, wastewater treatment and carbon sequestration. Through smart strategies and reduced material consumption, we find that the circular economy has the power to shrink global GHG emissions by 39% and cut virgin resource use by 28%.

Wastewater is only a minor area of the bioeconomy, but is nevertheless one to which we would like to bring to the attention of both Government Departments, particularly as wastewater is mentioned in the Department's consultation document only once.[74]

In a world threatened by climate change, the drive towards a more environmentally friendly economy is not an option, it is an obligation, and improved management of our wastewater is a crucial element of this. To achieve such sustainable development, the bioeconomy, which the United Nations Food and Agriculture Organisation (FAO) defines as "*the production, use and conservation of biological resources, including related knowledge, science, technology, and innovation to provide information, products, processes and services to all economic sectors with the aim of moving towards a sustainable economy".*

The need for knowledge-based production and the use of biological resources, processes and methods to provide goods and services in a sustainable manner in all economic sectors has become essential.

Zero Waste Alliance Ireland has a long and continuing interest in a topic which we have brought up in many past submissions, i.e., the importance of recovering phosphorus and nitrogen from domestic wastewater, which can then be used to

[74] Section 6.6 "Communities Pillar", 2022 Bioeconomy Action Plan Consultation and Discussion Document prepared by the Department of Environment, Climate and Communications.

make a product known as Struvite, which can subsequently be used as an agricultural or horticultural fertiliser.

It has always been our policy that wasting plant nutrients (nitrogen and phosphorus) essential for agriculture and food production cannot be seen in isolation, but must be addressed as part of a larger issue, in this case a bioeconomic issue. Phosphorus is currently being wasted by our communal failure (as a society) to recover it. Wastewater is in fact a valuable resource, but it is not yet regarded as one. Struvite can easily be created by the separation of urine from domestic wastewater, through the use of urine separating toilets for example.

According to a recent paper on phosphorus balance in Irish soils, and estimating the quantities of phosphorus needed, approximately 43,000 tonnes of imported phosphorus fertilisers are annually applied to Irish agricultural land; 95,500 tonnes of phosphorus are required annually to sustain crop production and build soil phosphorus, and 62.8% of Irish agricultural land has agronomically suboptimal phosphorus levels.[75] The paper estimates that cattle produce the largest quantity of indigenous phosphorus annually (19,300 tonnes), and Ireland produces approximately 30% of its phosphorus requirements from indigenous sources. If Ireland could encourage a certain percentage of the population to separate urine, we would increase our indigenous phosphorus thus becoming less reliant on imported sources which are finite, and as a result ensuring our future food security.

10. Importance of Research, Development and Innovation in the Circular Bioeconomy

Research, development and innovation are essential in the development of the bioeconomy. Incentives through government grants and schemes should be provided to support the transition of energy intensive businesses that rely heavily on greenhouse gas emissions, moving them towards circular business models.

The development of the bioeconomy in Ireland, and worldwide, should be knowledge-based and should be underpinned by research and innovation. Patents on biological substances with medical value, and patents on genetic resources will likely become more common, though this should be discouraged. As these useful substances and genetics are "discovered" in nature, it stands to reason that a functioning, diverse biosphere is essential to the development of the bioeconomy. As the global biosphere is destroyed, more and more species

[75] Ciarán O'Donnell, Aoife Egan, Joe Harrington, Denise Barnett, Patrick Forrestal, Niamh Power, An overview on deficit and requirements of the Irish national soil phosphorus balance, Science of The Total Environment, Volume 785, 2021, pp3

become extinct, and along with them the potential for a new antibiotic drug or treatment for a rare disease. Therefore, the preservation of biodiversity in Ireland will maintain a "bank" of genetic resources that will prove beneficial to public health and the economy.

Similarly, a healthy, functioning biosphere provides value to the economy by providing ecosystem services. These services are estimated to have a value in the trillions.

11. Awareness Raising; Developing our Knowledge and Skills; Earth Literacy and Ocean Literacy; Empowering Communities

When considering what key issues should be prioritised around communities in the bioeconomy action plan, ZWAI advocates that supporting communities through incentives by empowering them to make woodlands and create habitats that work for the plants, the soil, nature, and the people who live there should be a key issue. This could potentially take place in schools, church grounds, parks, brown fields, social clubs and car parks. Connecting existing wild spaces and giving shelter and protection for animals to move stealthily, creating more incentives for communities to dedicate areas for recreational use should also be prioritised, given the benefit we have seen that these areas have on the mental and physical health of individuals within communities.

Furthermore, improving the education of our communities around the environment, biodiversity and climate change is essential and should be integrated into the bioeconomy. An innovation for education systems including "Ocean Literacy" could contribute effectively to the protection of marine ecosystems, as the implementation of blue bioeconomy patterns for future generations in general, especially in coastal countries is vital. "Earth Literacy" can incorporate "Ocean Literacy" as an educational program which can be brought to schools, businesses and communities with the intention of raising awareness and ultimately connecting our communities further to nature and benefiting the bioeconomy as a result.

12. SUMMARY AND RECOMMENDATIONS

1. The Bioeconomy Action Plan should be expanded to include an "All-of-Government" approach, similar to the Climate Action Plan, and the Government's proposals for waste reduction and the Circular Economy. In fact, it is difficult to see which government departments should not be engaged one way or another with Ireland's Bioeconomy Action Plan.

2. There is a need for reform of Ireland's agricultural and forestry policies and programmes, as these are key to the effective formulation and implementation of the future Bioeconomy Action Plan. Other policy areas, such as energy security, where we are especially concerned about the waste of energy, and the inefficient use of energy, must also be closely integrated with the Bioeconomy Action Plan.

3. Land use, agriculture, forestry and the management of our freshwater and marine resources, especially including living aquatic organisms which contribute to the bioeconomy, should be the subject of an integrated policy, which takes no account of administrative boundaries, for the simple reason that such artificial boundaries are not heeded by living creatures.

4. We have several closely-linked crises in Ireland: a climate crisis, biodiversity crisis, a critical raw materials crisis, an energy crisis, a food security crisis, a public health crisis, and an inequality crisis. Urgent action is needed to address these; and, particularly in the areas of climate and biodiversity, we have approached critical points where system change has become close to tipping points and may be irreversible.

5. There is a need for a strong coherent policy to address all of these emergencies in a practical and integrated manner; and this should include bioeconomy-related issues.

6. The bases of our bioeconomy are other living creatures, whether in the soil, on the land surface, in water, and in our oceans and seas; and we get a sense in the document that the emphasis on promoting growth in the bioeconomy, and on production and export of increasingly greater quantities of products, takes no account of the adverse effects of transportation, nor the fact that we live on a finite world; and we must live within the carrying capacity of the planet.

7. It is our submission that a much more ecological and earth-friendly approach to the bioeconomy is needed, based on a growing awareness of the vulnerability and limitations of our planet's supporting ecosystems; and we can describe this awareness as "Earth Literacy" and "Ocean Literacy".

7. Without a high level of understanding and awareness, and a science-based approach, our bioeconomy policies and programmes will either fail or have damaging consequences.

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This submission was researched and edited by Jack O'Sullivan (ZWAI founder member, director and environmental scientist) with substantial research and contributions by Órla Coutin (ZWAI administrator and researcher), Jack Coffey (ZWAI member), Ioanna Votsku (ZWAI member) and Stephanie McEvoy (Farming Carbon).

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