

Marie-Jacqueline LEONTE

*Institute of Agricultural Economics, Romanian Academy, Bucharest
leonte@eadr.ro / Jacqueline.Leonte@gmail.com*

CARBON FOOTPRINT OF AGRI-FOOD SECTOR AND THE CONCEPT OF “FARMFLUENCERS”

ABSTRACT

The purpose of this paper is to create a clear image of what a “farmfluencer” means in the area of carbon footprint of agri-food sector.

In this endeavour, it is important to start from greenhouse (GHG) gases emissions, the concept of carbon footprint and then identify the particular aspects of carbon footprints of agri-food sector. Only a proper vision on the subject can lead to a plan for reduced carbon footprint, especially in the agri-food sector. Generally speaking, the agri-food sector is attractive, competitive, resilient, future-proof, fair, with investments and solid entrepreneurship for generational renewal. The main actions at the farmer level are to enhance resilience to risks and crises.

The importance of the farmers is given by the possibility to develop excellence, using all the opportunities for farmers from bioeconomy, nature and climate protection (*i.e.* carbon and nature credits). Mainly the young farmers are interested in promote their best practices and exchange data and information with similar individuals. They are the “gems” that can create a network of “Farmfluencers”.

Key words: GHG emissions, carbon footprints, agri-food sector, farmfluencer.

JEL Clasification: Q54, Q18, Q16, L31

1. INTRODUCTION

Climate change has been scientifically recognized for over a century, but its importance in public and political discourse has grown in distinct waves.

The early scientific awareness regarding climate change (19th–20th Century) was mainly a scientific curiosity: Eunice Foote (1856) theorized the greenhouse effect, showing that CO₂ traps heat, Svante Arrhenius (1896) calculated that CO₂ emissions from burning coal could warm the Earth and Guy Callendar (1938) linked rising global temperatures to CO₂ emissions.

Modern scientific consensus begins in the period 1950–1980, marking a turning point in institutional and international recognition: Charles David Keeling (1958) began measuring atmospheric CO₂ (Keeling Curve), The first **World Climate Conference (1979)** recognized climate change as a potential global threat and The **Intergovernmental Panel on Climate Change (IPCC)** was established by the UN in 1988.

Public and political awareness increased during the period from 1990 to 2000, with the Earth Summit in Rio de Janeiro in 1992 leading to the establishment of the United Nations Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol in 1997 becoming the first international treaty to set binding targets for greenhouse gas (GHG) reductions.

In this context, after 40 years since the recognition of climate change as potential threat, a vision with clear concepts to operate with is more compulsory as ever. When there is a robust vision in place, it is easy to create an action plan aiming at finding smart solutions to the *status quo*. Al Gore's film *An Inconvenient Truth* (2006) brought the issue to mainstream media.

Urgency increased since 2015, when The Paris Agreement was signed, aiming to limit global warming to below 2°C. In 2018, Intergovernmental Panel on Climate Change (IPCC) released a landmark report warning of severe consequences if warming exceeds 1.5°C. In 2019–2020 period, youth-led climate movements (like Greta Thunberg's Fridays for Future) surged globally. Since 2020, climate change became a top political issue in many countries, influencing elections, policies and global summits (e.g. COP26, COP28). From the official slogan of COP26 "Uniting the world to tackle climate change" to the COP28 motto "Foster innovation to better measure adaptation" is a long way.

2. STATE OF KNOWLEDGE

Carbon footprint is an indicator of human activities impact on climate change and an indicator of environmental sustainability (Toma, 2021). The importance of clearly defined concepts allows researchers to make comparable analysis, at farm level, at an organization level, such an agricultural processing cooperative, at a sector level (agriculture production sector, food system, waste disposal management), at an event such a an agri-food fair or for a product (e.g. 1 kg of wheat or 1 kg of meat).

International standards are available to understand principles, framework, guidelines and proper quantification: ISO 14040 on International Life Cycle Assessment (LCA) – principles and framework, ISO 14044 on Environmental management (LCA) – Requirements and guidelines, ISO 14064-1 on GHG emission quantification and ISO 14067 on GHG – Carbon footprint of products (Requirements and guidelines for quantification).

According to Kruti Davta (2025), there are top 10 polluting industries in the world, that support the idea that agriculture and food production altogether with food retail and waste contribute significantly to greenhouse gas (GHG) emissions. This is the situation in Romania, but also throughout the world.

According to FAO method, each industry's ranking was determined using the cumulative environmental footprint, from resource extraction to end-of-life disposal (FAOSTAT, 2022), making possible a clear understanding of agri-food impact.

3. MATERIAL AND METHOD

The bibliographical material used included the documentary materials to which reference was made: the standards related to GHG and carbon footprint, relevant specialized books in the field, analyses and studies, data and information from the specialized literature, official documents of various national and international bodies: European Union/Commission, Food and Agriculture Organisation (FAO) and Organisation for Economic Co-operation and Development (OECD) published on the specific webpages. These sources covered for the most updated data and information (2025). This paper is based on scientific published literature (published scientific articles and articles from the specialized press) in order to explore the concept of “farmfluencer”. The research tool was based on the analytical and descriptive method.

The existence of the greenhouse effect (while not named as such) was proposed as early as 1824 by **Joseph Fourier**. The term *greenhouse* was first applied to this phenomenon by **Nils Gustaf Ekholm** in 1901. The *enhanced greenhouse effect* describes the fact that by increasing the concentration of GHGs in the atmosphere (due to human action), the natural greenhouse effect is increased. The carbon footprint considers various sources of emissions, including the burning of fossil fuels (coal, oil, and gas) for energy production, transportation, industrial processes, agriculture, deforestation, and waste management. These human activities release: 75% of carbon dioxide (CO₂) from production of electricity, heat, transport and production, 20% of methane (CH₄) from agriculture, fossil fuels and waste and 5% of nitrous oxide (N₂O) from agricultural fertilizers. There are direct emissions of nitrous oxide (N₂O), indirect emissions of nitrous oxide (N₂O) and other greenhouse gases (GHG) emissions into the atmosphere, calculated as carbon dioxide equivalent (CO₂eq).

At the **fifth Assessment Report (AR5) of The Intergovernmental Panel on Climate Change (IPCC, 2014) have been introduced also:** emissions (CO₂eq) (AR5), emissions (CO₂eq) from F-gases (AR5), emissions (CO₂eq) from CH₄ (AR5) and emissions (CO₂eq) from N₂O (AR5).

Even the paper is using databases for examples regarding Romania in the world context, the approach is a theoretical one. Main aim is to research and provide a comprehensive concept for the “farmfluencers” from the agri-food sector.

4. RESULTS AND DISCUSSIONS

4.1. GREENHOUSE GASES (GHG) EMISSIONS AND CARBON FOOTPRINT

It is obvious that slowly, an action plan has been developed. It has started with the awareness of the climate change impact (loss and damage, GHG emissions) and the necessity to tackle climate emergency critical issues: adapt to climate impacts, build resilience, reduce GHG emissions, build resilience and adapt

to the inevitable impacts of climate change and finance climate action in developing countries. COP28 goal to keep the 1.5°C warming limit within reach has led to an ambition COP29 aim – to establish an agreement to triple financial assistance to developing countries, aiming for at least \$300 billion per year by 2035, in order to help them mitigate and adapt to climate change (Table 1).

Table 1

Evolution of the main goals of the Conference of the Parties (COP) under UNFCCC

Code	Year	Place	Main goals
COP25	2019	Madrid, Spain	<ul style="list-style-type: none"> – international carbon markets (Art. 6) – to tackle key areas of focus: adaptation to climate impacts, loss and damage, and climate finance
COP26	2021	Glasgow, UK	<ul style="list-style-type: none"> – greater transparency in reporting progress and trading emissions reductions between countries – strengthening the efforts to build resilience to climate change, curbing GHG emissions, and providing necessary financing
COP27	2022	Sharm El-Sheikh, Egypt	<ul style="list-style-type: none"> – to rely on outcomes of COP26 to deliver action – to tackle climate emergency critical issues – to reduce GHG emissions – to build resilience and adapt to the inevitable impacts of climate change – to finance climate action in developing countries
COP28	2023	Dubai, United Arab Emirates	<ul style="list-style-type: none"> – to tackle climate change – to keep the 1.5°C warming limit within reach – to implement key topics like a global stocktake, transitioning away from fossil fuels and accelerating the shift to renewable energy.
COP29	2024	Baku, Azerbaijan	<ul style="list-style-type: none"> – to enhance climate ambition and enable action, with a strong emphasis on climate finance – to establish an agreement to triple financial assistance to developing countries, aiming for at least \$300 billion per year by 2035, to help them mitigate and adapt to climate change

Source: Author's analysis, United Nations Framework Conventions on Climate Change (UNFCCC).

In 2025, COP30 will be held in November in Belem, Brazil and will focus on Amazonian Climate Change.

According to Kruti Davda, an environmental engineer hailing from India, deeply passionate about air quality research and atmospheric science, there are 10 polluting industries in the world, taking in consideration the five major types of pollution affecting the world and contributing to global warming and climate change in 2025.

Agriculture and food production account for up to 18% of global GHG emissions, while Food waste it's estimated to cause 8–10% of global GHG emissions. At a gross estimation, the agri-food sector counts for minimum 28% global GHG emissions. Not to mention that waste management and landfills generate around 20% of global methane emissions.

Box 1

Top 10 polluting industries in the world (2025)

- “1. Fuel & Energy is the top polluter, contributing to around 75% of global GHG emissions from fossil fuels like coal, gas, and oil;
2. Agriculture and food production account for up to 18% of emissions, largely from livestock, land-use changes, and ammonia pollution;
3. The fashion industry (especially fast fashion) is behind 8–10% of global carbon emissions, and generates massive textile waste and water pollution;
4. Food retail and waste contribute significantly to emissions, with 1.9 million tonnes of food wasted annually in the UK alone, and high emissions from refrigeration and plastic packaging;
5. Transport is responsible for one-fifth of global CO₂ emissions, with road vehicles being the main culprit, followed by freight and air travel;
6. Construction causes 23% of air pollution, releasing dust, gases, and using energy-intensive machinery, especially in fast-growing urban areas;
7. Technology, including data centers and cryptocurrency, uses huge amounts of electricity and is rapidly becoming a major emissions source;
8. Plastics manufacturing pollutes the air and water, especially through burning and improper recycling, releasing toxic chemicals into the environment;
9. Waste management and landfills generate around 20% of global methane emissions, a powerful greenhouse gas; smarter monitoring and waste-to-energy tech are key solutions;
10. Chemical manufacturing releases VOCs, NO_x, SO₂, and PM, all of which contribute to smog, acid rain, and serious health issues.”

Source: Kruti Davta, Top 10 Most Polluting Industries in the World (2025), <https://oizom.com/most-polluting-industries/>.

The Carbon Trust UK first released its **definition of a carbon footprint** in **March 2007**, when it launched the world’s first carbon footprint label verification with a public standard: “The carbon footprint is the total amount of greenhouse gas (GHG) emissions measured in carbon dioxide equivalent (CO₂eq), that are released directly or indirectly by an individual, an organization, an event or a product.” This initiative allowed companies to transparently measure and communicate the lifecycle greenhouse gas emissions associated with their products.

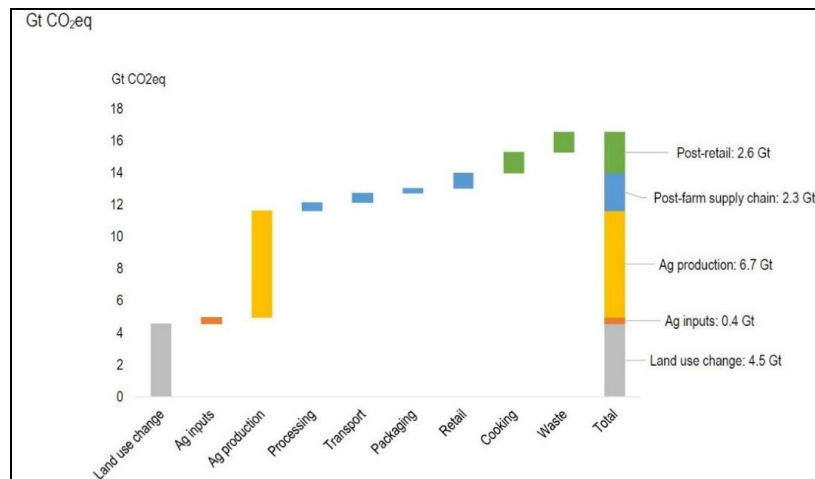
The development of the underlying methodology began earlier. The Carbon Trust had been working with companies since around 2004–2006 to develop a robust approach to measuring product and service carbon footprints. In **March 2007**, they formally rolled out the initiative – including both the measurement methodology and the label itself. Following that, in **2008**, the PAS 2050 standard was formally announced through BSI and Defra as a standardized specification for assessing lifecycle greenhouse gas emissions of goods and services.

In time, GHG emissions in agri-food sector have been measured for activities over a specific period. For the purpose of this paper, only carbon footprint calculated in agri-food sector has been taken into account. Even the databases information is available at activity level (*e.g.* agriculture production, food industry, waste management and several industrial sectors, such as energy, construction, transportation etc.), the farmers operate at individual, organization or product level. The “farmfluencers” can be related only to agricultural production, food industry and waste disposal in agri-food systems.

4.2. CARBON FOOTPRINTS OF AGRI-FOOD SECTOR

An important part of the Global greenhouse gas (GHG) emissions is the result of agriculture, deforestation (land-use changes) and food production. Due to various agricultural practices and processes, “agricultural production” takes into account: rice cultivation, crop residues, burning of agricultural residues, enteric fermentation, manure management (animal waste management, manure left on pastures, manure applied to soils), synthetic fertilization, drained organic soils, on-farm energy use and farm waste management. In the agricultural account we introduce fertilizers and pesticides manufacturing. “Food production” take into account: food processing, food packaging, food retail, food household consumption, food transport and agrifood systems waste disposal.

Food systems account for an estimated one-third of global GHG emissions (Figure 1). According to OECD method is that “Land” includes emissions from net forest conversion, drained organic soils and fires. “Agricultural inputs” here refers to emissions related to the production of agricultural inputs. Emissions related to their use are included in “Agricultural production”.



Source: OECD, 2025.

Figure 1. Global food systems GHG emissions by supply chain stage, 2019.

When we think about pollution, farming might not be the first thing that comes to mind, but it should be. The big problem is considered the livestock farming. Cows and other animals release large amounts of methane and nitrous oxide, both powerful **source of GHG**. Add to that the fact that 70% of the world’s freshwater goes into farming, and it is clear how resource-heavy this industry is. There’s also the issue of ammonia emissions from livestock manure and fertilizers, which are major contributors to particulate matter in the air. In European cities, ammonia from farming is behind more than half of particulate matter related air

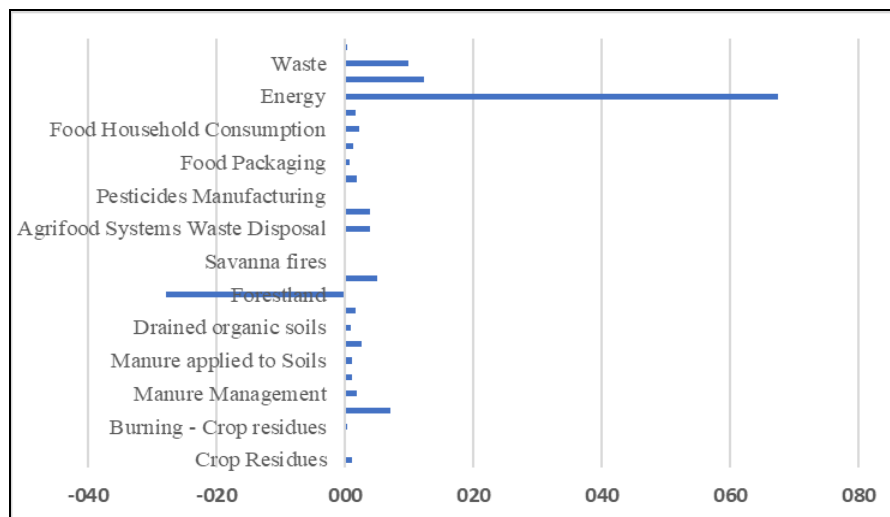
pollution. Then there’s deforestation. Forests are cleared to make way for crops or pasture, especially for high-demand industries like palm oil and cattle. Farming feeds the world, but it’s also feeding pollution.

Even what we eat matters. When we think of pollution in food, farming usually gets the blame. But the retail side, supermarkets, restaurants, and packaging, plays a huge role too. As the global demand for food rises, so does the environmental cost. From plastic packaging to food waste, this sector is producing a surprising amount of pollution. That’s not just leftovers in the fridge. It’s unsold food from grocery stores, restaurants, and suppliers that gets thrown out.

Food waste is a big deal. It’s estimated to cause 8–10% of global GHG emissions. In the EU, nearly 57 million tonnes of food are wasted annually, which comes out to 127 kg per person. Also, in the UK alone, about 1.9 million tonnes of food are wasted every year, a record high. The average grocery store emits nearly 3,000 metric tonnes of CO₂ each year, mostly from electricity and leaked refrigerants. And since refrigeration uses over half of their electricity, it’s a major source of energy-related emissions. Food retail might look clean and convenient, but behind the scenes, it’s a heavy polluter.

Similar to Figure 1, this report aims at analysing the Romanian GHG emissions released into the atmosphere, contributing to global warming and climate change.

According to FAOSTAT, total emissions disseminate information estimates of CH₄, N₂O, CO₂ emissions/removals, F-gases and their aggregates in CO₂eq in units of kilotons (kt, or 10⁶ kg). The latter are computed by using the IPCC Fifth Assessment report global warming potentials, AR5 (IPCC, 2014). Figure 2 presents the situation in 2022, calculated as percentages for an easier interpretation of the Romania’s GHG emissions inventory.

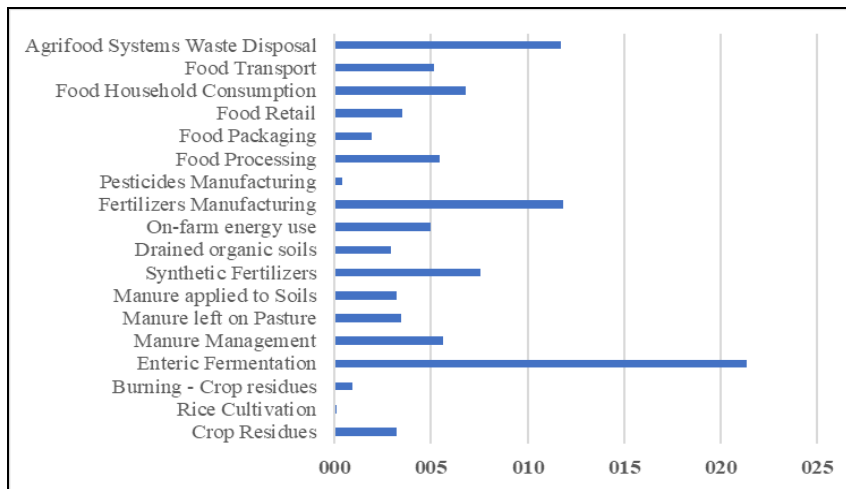


Source: Author’s calculations based on FAOSTAT, 2025.
Figure 2. Romania’s GHG emissions inventory for 2022 (%).

Under the guidelines of the **Intergovernmental Panel on Climate Change (IPCC)**, the GHG inventory for Romania in 2022 reveals the fact that energy and waste from industrial sector is huge: 70 to 80%. In order to obtain a comparable figure with the world situation in 2019 (Figure 1), we eliminate part of the indicators:

- Forestland, Net Forest conversion, Savanna fires, Forest fires,
- Energy sector, including: Fuel Combustion (burning fossil fuels for energy in various sectors, such as Power plants, vehicles, buildings), Fugitive Emissions from Fuels (**Extraction** of coal, oil, and gas; **Processing** and **transport** of fuels), Energy Industries (electricity generation, oil refineries, combined heat and power plants, gas processing facilities).
- IPPU emissions, including: **cement production** (CO₂ released during the chemical conversion of limestone into clinker), **refrigerants and air conditioning** (hydrofluorocarbons used in cooling systems), **metal production** (emissions from processes like aluminium smelting), **chemical production** (GHGs from ammonia or nitric acid production), **solvent use**, **electronics manufacturing** and more.
- General waste and Others.

A special mention has to be made, that in the Energy sector are also included emissions from the manufacturing of tractors and agricultural machines, including generators.



Source: Author's calculations based on FAOSTAT, 2025.

Figure 3. Food systems GHG emissions in Romania by supply chain stage, 2022 (%).

Crop residues and burning – crop residues are aprox. 4%, while the enteric fermentation is by far the most important GHG emissions producer (21.34% from total Food systems GHG emissions in Romania). Manure counts for 12.22%, out of

which: 5,60% manure management, 3,43% manure left on pasture and 3.19% manure applied to soils. Related to fertilizers, there is a total of 19.39% (7.55% use of synthetic fertilizers and 11.85% fertilizers manufacturing).

The food sector adds 22.81% of total GHG emission in the agri-food sector, out of which: food processing – 5.44%, food packaging – 1.91%, food retail – 3.52%, food household consumption – 6.78%, food transport – 5.16%.

Agrifood Systems Waste Disposal has a big role to play in the GHG emissions in Romania – 11.75%.

To summarize, there are similarities between Figure 1 and Figure 3, in the sense that in the world, agricultural production and its inputs represent 70.3% and food production and agrifood systems waste disposal is 29.7% out of Global food systems GHG emissions by supply chain stage, while in Romania, the shares of the two sectors (agriculture and food production & agrifood systems waste disposal) are 65.44% and 34.56% respectively.

If we try to adapt the Carbon Trust UK definition of a **carbon footprint in general to the definition of a carbon footprint in agri-food sector**, then “The carbon footprint of agri-food sector can be considered the total amount of greenhouse gas (GHG) emissions measured in carbon dioxide equivalent (CO₂eq), that are released directly or indirectly by a farmer, an organization/ agricultural cooperative, an event (an agricultural fair) or a product (*e.g.* milk, cheese, eggs, meat), including the waste disposal of the agri-food systems”.

4.3. THE CONCEPT OF “FARMFLUENCERS”

There’s a growing trend toward region-specific carbon footprint assessments, standards integration (like ISO 14040/14044) and exploring carbon sequestration paths (*e.g.* agroforestry, cover cropping). In terms of carbon footprint of agri-food sector, a farmer has to start implementing methods for calculating the GHG emission at farm level, per product (*e.g.* wheat, barley, animal husbandry, poultry meat, processed meat at farm level). This task is a challenge for food industries, for importers and exporters from this area. Farm level calculation tools allow farmers to use primary data on their activities and management practices as inputs to calculate their carbon footprint. It is quite hard for farmers to perform these calculations. Some online calculators are available at the level of some organisations, in order to support the farmers, but results may vary from one tool to another.

A **farmfluencer** is a blend of the word “**farmer**” and “**influencer**.” A farmfluencer is a person involved in **farming or agriculture** who uses **social media digital platforms** (like social media, blogs, Instagram, YouTube, TikTok, etc.) to **share content** related to their knowledge, experiences, and insights **in order to educate**, and **influence** an audience about topics related to farming, agriculture, rural life, sustainability, and food production.

They influence their audiences by highlighting farming practices, sustainable agriculture, crop management, livestock care, and rural lifestyle, often aiming to educate, inspire, or promote certain products or methods. Essentially, farmfluencers act as digital ambassadors for the agricultural sector, connecting farmers, consumers, and the broader community through engaging and informative content. By combining their expertise in farming with a focus on environmental sustainability, farmfluencers play a vital role in inspiring other farmers, consumers, and stakeholders to adopt more eco-friendly practices, ultimately contributing to the global effort to reduce climate change. The farmfluencers can share behind-the-scenes life on the farm (crops, animals, equipment), promote sustainable and innovative farming practices, educate people about where their food comes from, inspire others to connect with nature and rural living. They can become partners with agricultural brands or food companies and increase their impact.

A farmfluencer related to carbon footprint at farm level is an individual involved in agriculture or rural life who leverages their platform to raise awareness about the environmental impact of farming activities. They share insights on how agricultural practices contribute to greenhouse gas emissions. It is certain that the process of reducing the carbon footprint within the sector will become compulsory. What is paramount is the fact that before this moment, the farmfluencers can:

- Promote sustainable farming techniques such as crop rotation, conservation tillage, or organic farming.
- Educate followers on the importance of reducing emissions from machinery, transportation, and fertilizer use.
- Showcase innovations like renewable energy integration on farms or eco-friendly packaging.
- Advocate for policies and practices that support climate-smart farming/agriculture.
- Demonstrate via simulations or tests how carbon footprint can be calculated and/or reduced.
- Discuss strategies with farmer followers or decision makers.

In agriculture, cleaner agricultural practices and smarter monitoring are the way forward. In food production, reducing waste, improving energy efficiency, and rethinking packaging can make a real difference. The farmfluencers can have a huge impact in agriculture and food sector, as well as waste disposal from agrifood systems. Some countries are taking action. France, for instance, banned supermarkets from throwing away edible food. Instead, they donate it to charities, cutting waste and helping people at the same time.

In the ideal Carbon Footprint assessments, the actors in the supply chain would be able to receive product carbon footprint information from suppliers, add their own emissions, and share the result with the next stage of the supply chain, all the way to the point where a consumer buys a food product. In the absence of primary data, only the first lever is available, based on averages. This would leave

important opportunities for emission reductions untapped, as the evidence shows that carbon footprints can vary considerably within the same product category (*e.g.* cheese) and are influenced by producers’ choices of techniques and practices. In this context, the farmfluencers have an important mission in **share content** related to carbon footprint of agri-food systems, **educate** and **influence other farmers to start calculating their farm’s** carbon footprint. It is not a sterile purpose of just quantifying the carbon footprint at farm level. The next major step is to take actions for carbon footprint reduction at farm level.

Recent studies (*e.g.* Swiss case studies using agent-based models) show that farmers’ social networks – including digital connections – boost adoption of GHG mitigation practices by enabling peer learning and behavioural imitation. This leads to more effective and cost-efficient mitigation outcomes.

Farmfluencers play an important role in: **bridging the gap** between farmers and consumers; **fighting misinformation** about food and agriculture; **inspiring youth** to consider careers in farming; **promoting environmental awareness** through real-world practices.

Social media influence in agriculture of the “farmfluencers” is considerable and consistent. Many individual farmers are actively sharing their experiences and knowledge about sustainable practices on social media platforms. Some agricultural organizations offer resources and support for these farmers. While not all of these influencers may use the term “farmfluencer,” their content and activities contribute to raising awareness about the carbon footprint of agriculture and promoting more sustainable food production systems.

If there is possible to define more or less accurate the concept of farmfluencer, it is quite hard to measure their knowledge diffusion & peer effects.

5. CONCLUSIONS

Between 2010 and 2050, global food demand is projected to grow by 56%. Sustainable agriculture can ensure food scarcity will not grow as the global population increases. In short – the benefits of sustainable agriculture are numerous. It can be hard to know where to start with sustainability, or how to reduce carbon footprint in agriculture.

Farmfluencers are potential developers of excellence. All the farmers are involved in the process of enhancing the farms’ resilience to risks and crises, since is a matter of economic survival. In order to become farmfluencers, they have to use all the opportunities from bioeconomy, nature and climate protection (*i.e.* carbon and nature credits), identify smart solutions and use the available innovation.

Farmfluencers can be credible. Online farm influencers are perceived as trusted sources, even if direct links to Carbon Footprint changes are not yet

quantified. For the time being, the farmfluencer can implement best practices to reduce Carbon Footprint on agriculture sector. For example: a dairy farmer posting daily routines and cow care tips, a young grower showing how to start a vegetable garden, a homesteader sharing self-sufficiency tips and recipes, a regenerative farmer educating followers about soil health, etc.

While there isn't a specific, well-known group of "farmfluencers" focused solely on carbon footprint reduction, several agricultural influencers and organizations are actively promoting sustainable farming practices and raising awareness about the environmental impact of food production. These include individuals and groups who focus on topics like:

- Regenerative agriculture: advocating for farming methods that improve soil health and biodiversity, often leading to carbon sequestration.
- Sustainable livestock management: promoting practices like rotational grazing, improved feed management, and reducing reliance on fossil fuels in animal agriculture
- Precision agriculture: using technology to optimize resource use (water, fertilizer, etc.) in crop production, minimizing waste and environmental impact.
- Local and seasonal food systems: encouraging consumption of locally sourced and in-season produce to reduce transportation emissions and support regional economies.

Farmers investing in their own education, investing in the newest farming solutions and aiming at developing agricultural activities and processing activities for their own produce at the farm level, taking responsibility for the waste management are the farmers of the future. Some of them will be pilot-projects, as a beacon, a row model to their communities, demonstrating that "Where there's a will, there's a way!"

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