A comparison of animal and plant-based proteins from an economic, environmental, and nutritional perspective

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Abstract

1. Introduction

As a result of the growing global population, food demand is expected to grow by 1.3% per annum by 2030 (OECD/FAO, 2021). Proteins are a central part of nutrition as they constitute the building block of several vital mechanisms for the human body. According to the Eat-Lancet commission, animal proteins are largely overconsumed, and plant-based protein largely under-consumed in Europe. (The Lancet Commissions, 2019). In 2020, agriculture was responsible for 10.3% of total greenhouse gases (GHG) emissions across the European Union (Eurostat, 2021). In 2017, enteric fermentation and manure management from livestock production accounted for about 50% of total agricultural emissions in the European Union (European Commission, 2020). Agriculture will therefore be a key sector when it comes to reducing GHG emissions.

Overall, plant-based proteins are considered more environmentally sustainable compared to animal proteins (Detzel et al., 2021). Additionally, there is a consumer trends towards the consumption of more plant-based proteins (Tziva et al., 2019). However, some argue that animal and plant-based proteins are not equal in terms of amino-acid composition and digestibility, metrics for which animal proteins have better recorded performances (Day et al., 2022).

This paper considers how plant-based proteins compare to animal proteins from an economic, environmental, and nutritional perspective. In particular, the paper considers if global consumption of plant-based proteins should increase, and if so, what policy interventions would

be needed for farmers to shift their production towards more environmentally sustainable systems to facilitate this?

2. Methodology

This analysis is carried out using data from the Republic of Ireland and compares three sources of animal proteins (milk, sheep meat, and beef meat), and five sources of plant proteins (winter and spring oats, winter and spring barley, and winter wheat). The main dataset came from the Teagasc National Farm Survey (NFS) which is part of the EU Farm Accountancy Data Network. The NFS dataset gives a population weight to each farm to make them representative of a given number of farms in the national population based on farm size and system type.

Gross margin is used for the economic evaluation, and GHG emissions (CO_2 equivalent) for the environmental evaluation of each source. For the nutritional aspect, we use the gross protein yield and the digestible protein yield. The latter is obtained by multiplying the gross protein yield by the DIAAS (Digestible Indispensable Amino Acid Score), giving us the amount of protein that will be used by the human body after digestion (FAO, 2013). All indicators are expressed per hectare, per 100 grams of protein, and per 100 grams of DIAAS-corrected protein to account for overall performance as well as protein performance.

3. Results

The results indicate that milk is the more economically profitable but has the highest level of GHG emissions for protein produced per hectare. Sheep and beef meats have the highest level of GHG emissions after milk but are the least profitable protein sources per hectare. They also have the lowest gross and available protein yields amongst all sources. They are then considered highly inefficient protein sources. If we consider milk as the reference animal protein source due to its very high profitability, we can compare it with plant-based protein sources in terms of profitability for farmers, as it can be considered the most important factor for them. On a per hectare basis, while spring oats is associated with the lowest level of GHG emissions, it is five times less profitable than milk. Winter oats, the protein sources with the better qualitative (i.e., highest gross protein yield) and quantitative (i.e., highest digestible protein yield) nutritional performances of the plant sources, is four times less profitable than milk. Winter wheat, the most profitable of plant-based protein sources, is still three times less profitable than milk. From a nutritional perspective, plant-based proteins yield more protein per hectare than animal proteins. Winter oats, the best performing plant protein source, gives about three times as much

gross protein per hectare than milk, the best performing animal protein source. The gap is narrowed when considering the available protein yield. Milk now has a yield greater than three out of the five plant protein sources. Winter oats gives only about 1.5 times more available protein than milk. GHG emissions per 100 grams of available protein are substantially lower for plant-based protein (between two and six times lower than milk), but so is the gross margin on the same basis (between three and seven times lower than milk). From an environmental perspective, a shift away from livestock production towards more arable-based production systems is beneficial. However, cereals are less profitable, making this shift unattractive to farmers.

4. Discussion & Conclusions

Policy interventions will be required to shift land use from animal to plant-based protein production.

According to our results, sheep and beef perform poorly economically, environmentally, and nutritionally. Milk is the only animal protein source which performs well economically and nutritionally. A transition from milk towards crops production first raises the issues of land suitability and farmers' knowledge, as these are two very different production systems. From an economic perspective, the profitability per hectare of crop production would need to increase three to five-fold to be comparable to milk production. To bridge this economic gap, policy is required to subsidize plant-based protein further or to implement policies to improve its productivity or profitability. Policy should also aim at correcting the gap between EU farmers and the rest of the world in terms of access to technology. Difference in legislation when it comes to the use of biotechnology or GMOs, for example, not only acts as a barrier to the use of tools than could help increase the profitability of crops, it also acts as a competitive disadvantage for European farmers compared to farmers operating in countries where the legislation is less strict. (ISAAA, 2017).

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