# Protein Consumption and Income Growth

Subjects: Economics

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Consumption and production of proteins derived from animals have more significant environmental and health impacts than proteins derived from plants. This raises concerns mainly in consideration of the predictable increased consumption of animal proteins at the expense of vegetal ones due to growing income, especially in developing countries. Animal protein consumption, and particularly meat consumption, seems to start to decrease at a high level of income, which may suggest that economic growth solves or attenuates the environmental and health problems of animal food consumption. Though there is actually some evidence of an inverted U-shaped relationship between per capita income and animal protein consumption, the peak is at such high levels as to make economic growth irrelevant to curb animal protein consumption.

Keywords: protein transition ; animal protein ; vegetal protein ; meat consumption

## 1. Increasing consumption of protein worldwide.

Proteins are nutritionally crucial and they have a pivotal role in the food system and for food security, as a lack of them is one of the primary causes of malnutrition (Aiking, 2011) [1].

Proteins in foods and beverages can originate from animals (meat, poultry, seafood, eggs and dairy products) or from plants (legumes, vegetables, grains, nuts and seeds). There are substantial differences between animal and plant proteins. Recently, the discussion on animal and plant proteins has become crucial because of their different impact on the food system's long-term sustainability. An overconsumption of animal proteins has important environmental and health consequences. Consumption projections (OECD, 2001)[2] have shown a continued shift in dietary patterns away from staples and towards animal products. Worldwide, the consumption of meat, dairy and eggs is increasing (Kearney, 2010) [3].

While in some Western countries the total per capita consumption has exceeded the recommended values (the Safe Level of Protein Intake is 0.83g/kg/day) of 150-200% (Aiking, 2014)[4], in some developing countries most people struggle to reach an adequate intake.

The increase in total protein consumption, in particular of animal origins, is attributed both to the rise in population, and to the rise of per capita consumption. Not only has per capita consumption grown, but there are also millions more consumers. The increase in the consumption of animal proteins in developing countries has been called "livestock revolution" (Delgado, 2003)[5] and it is due primarily to the increase in affluence in many countries. The Livestock Revolution has been most evident in Asia, where the consumption of animal product has increased 30-fold since 1961.

## 2. Protein consumption impacts.

Excess consumption of animal proteins, particularly if derived from meat, is linked to a rise in several pathologies and, as a result, in health system costs. Epidemiological studies suggest that the increasing amounts of red meat and processed meat consumption are associated with a higher risk of total mortality, cardiovascular disease, colorectal cancer and type 2 diabetes (Richi et al., 2015)[6] and correlated with worldwide obesity (Henneberg, 2016)[7].

Recent analyses have valued the health benefits of a transition towards plant-based diets. Springmann et al. (2016)[8] calculated it would reduce global mortality by 6–10%. The authors project that adopting a vegan diet would result in 8.1 million avoided deaths and 129 million life-years saved compared with the reference scenario. In addition, Song et al. (2016)[9] show that replacing animal protein of various origins with plant protein is associated with a lower mortality.

In addition to the health impacts from consumption, health impacts also result from emerging zoonotic diseases (including Bovine Spongiform Encephalopathy, avian influenza, Q fever and enterohemorrhagic Escherichia coli), which have been linked to livestock products. Resistant bacteria (e.g., methicillin-resistant Staphylococcus aureus, extended-spectrum b

lactamase) are another effect due largely to antibiotics used in intensive livestock production.

Increasing animal protein production has been identified as one of the most significant contributors to environmental pressures. According to Aiking (2014)[4], protein production is linked to the top three ecological impacts, for which we have already overstepped the planetary boundaries, i.e., climate change, biodiversity loss and nitrogen cycle disruption. Meanwhile, it has been suggested that the environmental burden of plant-based foods is lower than for animal products. This is because meat production is inherently resource-inefficient, with cattle being the least efficient converters of feed to meat: on average, 6 kg of plant protein is required to yield 1 kg of meat protein (Aiking, 2014)[4].

Livestock production is responsible for ~15% of all anthropogenic emissions (Godfray et al., 2018)[10], with the dairy industry accounting for 2.9% (Gerber et al, 2013)[11].

Livestock farming uses 70% of agricultural land overall and one-third of arable land (Chai et al, 2019)[12]. Land requirements for animal-based protein are 6–17 times higher than for soybeans (Chai et al, 2019)[12]. This is because plant-based proteins have a lower land intensity than meat since they use the crop directly (Swain et al., 2018)[13]. Livestock must be fed, and therefore livestock production results in land use competition, or food vs. feed production: one-third of the world's cereal is used as livestock feed each year (Speedy, 2003)[14]. This quantity contains energy to feed more than three billion people (Smil, 2002)[15]. Nearly one-third of global biodiversity loss is attributable to livestock production. According to Machovina et al. (2015)[16], reducing demand for animal-based food products and increasing proportions of plant-based foods in diets (the latter ideally to a global average of 90% of food consumed) will reduce the ecosystem and biodiversity impacts of animal product consumption, while meeting the nutritional needs of people.

Protein production is also responsible for large-scale fertilizer application, which contributes to the nitrogen cycle disruption.

Agriculture uses more freshwater than any other human activity, and nearly one-third of this is required for livestock (Godfray, 2018)[10]. One kilogram of edible beef requires 20 tonnes of water (Smil, 2002)[10]. In addition, water often ends up contaminated and, together with the waste generated by animals, represents a major source of regional and local environmental pollution (through eutrophication, acidification, leaching of nitrate and accumulation of phosphorus and heavy metals). More water is used for meat production than for plant protein production. One study finds that the difference between water input for animal protein vs. plant protein is generally around a factor of 26; even when intensive irrigation is needed for plant-based protein, animal protein production requires 4.4 times as much water (Chai et al, 2019) [13].

Likewise, the global demand for seafood is constantly growing, and many marine fish populations are overexploited (Westhoek et al., 2011)[17]. Global fisheries catches have been declining since the mid-1990s by approximately 1% per year, primarily due to overfishing. In 2017, fish accounted for 17% of animal protein and 7% of all protein consumption globally (Vianna et al, 2020)[18]. Fish production also relies on aquaculture, which can cause antibiotic resistance, biodiversity loss and death of the underlying seabed (Rizzo et al, 2016)[19].

## 3. Drivers of protein consumption: the importance of economic growth.

There are many food choice drivers, but budget constraints have received the most attention in the literature. It is well known that income affects dietary changes (Muhammad et al., 2017)[20], although the effect of income differs among developed and developing countries. According to Regmi et al. (2001)[2], low-income countries spend a greater portion of their budget on food and are more responsive to income change than middle- and high-income countries. Furthermore, low-income countries spend a more significant portion of their budget on staple food products, such as cereals, and when income increases, greater budget adjustments are made to higher-value food items such as dairy and meat. In general, as income increases, the tendency is to move up in the food chain (Smil, 2002)[10]. Popkin coined the term "nutrition transition" in the early 1990s to describe dietary changes that occur in response to economic development (Drewnowski et al, 1997)[21].

Historically, a close relationship between income and meat consumption has been observed: as a country becomes richer, meat consumption increases.

More recently, the intent is to see whether meat consumption decreases when a certain level of wealth is reached. Vranken et al. (2014)[22] suggest evidence of a second nutrition transition. In fact, an inverted U-shaped relationship between meat consumption and income indicates that average meat consumption reaches a maximum and then declines at a certain level of income. This has been termed a Kuznets relationship (for analogy with Kuznets's theory about income inequality (Kuznets, 1955)[23]. Depending on the specifications, the turning point identified by Vranken et al. (2014)[22]

varies between Int$35,035 and Int$52,661 per capita. Cole et al. (2013)[24], in a cross-section sample of high-income countries, find a potential Kuznets relationship and a decrease of meat consumption at a per capita income of US$49,848. In their full panel-data sample, combining high- and low-income countries, their results suggest an inflection point in meat consumption at an income of US$36,375 p.c. This value is much higher than US$15,000 per capita indicated by Vinnari et al. (2005)[25] for bovine meat consumption in EU-15 countries.

The choice and the quality of the protein appear to be driven not only by economic factors but also by geography, religion and culture (Drewnowski et al., 2018)[26]. In the literature, other drivers have been included in regression analysis to explain meat consumption. Milford et al. (2019)[27] find that income per capita and urbanization rates are the two most important drivers of total meat consumption per capita; religion is also a significant variable. In comparison, income per capita and natural endowment factors are major drivers of ruminant meat consumption per capita. Vranken et al. (2014)[22] propose a regression model to explain meat consumption, where religious persuasions, masculinity index, and trade (a proxy for a country's openness) play an essential role. Cole et al. (2013)[24], in addition to income, find urbanization and land availability to be significant determinants.

Our paper (Andreoli et al., 2021)[28] analyse animal vs. vegetal proteins p.c. consumption. The results suggest that, if any turning point exists, it corresponds to a high level of income, suggesting that a deceleration in meat and animal protein consumption will not happen unless a country reaches a per capita income of Int$77,000 and of Int$66,000, respectively. Given that many countries are far away from this level of income, and given the environmental and health concerns associated with the production and consumption of animal proteins, these results are not encouraging. Even though the Kuznets relationship seems to be confirmed from our data analysis, the Kuznets theory specification for which the demand should bring environmental and health advantages as income grows is not realistic in the case of protein consumption. This is confirmed also by the proposed vegetal protein consumption model, characterized by a U-shaped relationship with income: the share of vegetal protein consumption re-increases only when a per capita income of about Int$64,000 is reached.

In terms of policy implications, these results suggest that one cannot count on income growth to curb the negative health and environmental impacts of animal food consumption. The market alone fails to show signs of externalities associated with unsustainable protein consumption. Economic development alone won't, at least in the short run, bring a solution, and actions on different levels are needed to address this market failure. Given the scale of the challenges that the food system has to face in the context of sustainability, it is important to understand protein consumption trends and drivers, especially since different protein sources differ in terms of their environmentally damaging potential.

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