



The Food Versus Feed Debate: Could a Reduction in Meat Production Benefit Germany?

Maret Nürnberg¹, Elkhan Richard Sadik-Zada^{2,*},
Laman Yusubova³

¹ Ruhr-University Bochum, Universitätsstrasse 150, 44801 Bochum, Germany, meret.nuernberg@ruhr-uni-bochum.de

² Ruhr-University Bochum, Universitätsstrasse 150, 44801 Bochum, Germany, sadikebd@ruhr-uni-bochum.de

³ Ruhr-University Bochum, Universitätsstrasse 150, 44801 Bochum, Germany, laman.yusubovas@gmail.com

* Correspondence.

ABSTRACT

This paper aims to highlight various aspects of the discussion around meat reduction and provide a simplified, preliminary calculation of the potential gains that lay in reducing intensive meat production in Germany. In Germany, a reduction of meat production down to a level that would follow the recommendations of the World Health Organization for a healthy diet has the potential to free up a significant amount of land currently used to harvest animal feed, and instead harness it directly as agricultural land for food production. This sharp increase in available nutrition would increase the level of food security in Germany and consequently self-sufficiency, due to the reduction of import dependence.

Keywords: meat; food security; Germany

JEL Classification: N54, Q18, Q24

1. INTRODUCTION

With the demand for the consumption of animal products continuously rising over the last century around the world, it begs the question of whether the current amount of production is still reasonable. Excessive meat production has proven itself to be detrimental to environmental sustainability and human health due to excessive consumption. Animal products may provide more calories and higher-quality proteins than the same amount of plant-based products, but they also need substantially more input to be produced.

This inefficient utilization of resources has, despite the current situation of heightened uncertainty towards the reliability of global supply lines, which put the topic of self-sufficiency instead of reliance on imports to the forefront of public consciousness, surprisingly not yet been properly discussed as a possible solution to the issue at hand. The approach of optimal use of the available land to at least provide staple foods adds the additional dimension of intensive meat production then being a food security issue as well, with the potential to contribute significantly to stable domestic food supply if solved.

The “food vs. feed” debate implements the question of whether it is tolerable to use a big share of the available farmland purely for the cultivation of animal feed, instead of directly using it for human edible plants and thus consequently human food. This paper aims to highlight various aspects of the discussion around meat reduction and provide a simplified, preliminary calculation of the potential gains that lay in reducing intensive meat production in Germany.

Section 2.1 takes the form of a literature review and will briefly present the key findings from the most influential works in this field, to provide an introduction into the main issues surrounding meat production. Section 2.2 will then go into more detail on the resources affected and damage created by meat production. Section 2.3 highlights benefits and challenges of meat production, in order to provide an idea what general intensity of meat production and reduction could be considered. Section 2.4 contains the exemplary simple calculation what level of meat production reduction could be feasible in Germany, as well as a critical discussion of the effects. It also will briefly suggest how a reduction could be effectively achieved. Section 3 will sum up the main findings and conclude.

2.1 Literature Review

The food vs. feed debate has been addressed a number of times over the last two decades by various researchers already, each mostly focusing on one aspect only, such as the environmental impact or the role meat plays in the diet of consumers. Despite an overall consensus on the advantage of plant-based food items compared to livestock (Dagevos and Voordouw, 2013) and the general trend of world consumption of meat still rising as part of the ‘nutritional transition’ (De Boer and Aikingç 2011), there are very little efforts from policy makers to act on the basis of these findings (Dagevos and Voordouw, 2013). The following section will briefly highlight some of the most relevant works regarding the potential of reduction of meat production.

Smil (2002) goes into detail on how the consumption habits regarding meat have developed with the rise in wealth around the world. He then highlights the special role of meat as a desirable and often even status-affirming consumer good. This is then confronted by discussing the highly inefficient, unsustainable production of meat particularly in intensive livestock systems compared to the direct usage of crops as food for humans. He also mentions how this kind of production and consumption poses various health risks. The paper concludes with policy suggestions how meat consumption could potentially be reduced, using consumption patterns from the US as an example to show the most promising areas to target.

Godfray et al. (2010) provide an insight into the challenges faced by food security in the future. They point out the core problem of limited land being available, and how the historical solution of acquiring more food sources through cultivation of additional land is thus not sustainable for the future. While one major focus of the paper is the optimisation and development of current

productions to minimise losses, these types or strategies have generally more potential in developing countries due to the currently lower efficiency of production there. The change of production from livestock towards agriculture is identified as one option, but not unequivocally helpful. Especially on a global scale, a significant share of animals in non-intensive livestock systems feed on grazing instead of human edible grains.

Aiking (2011) deals in his paper primarily with the environmental impact and the issue of sustainable meat production. The biochemical impact of modern industrial agriculture and livestock cultivation are explained and connected to how they contribute to climate change via disruption of the natural nitrogen cycle. The effects of changing previously natural areas to anthropogenically used ones are laid out, and the potential of how current rations of farming land used for direct consumption and feed crops could be altered to increase the total available amount of food. Finally, some suggestions are indicated of how meat reduction and replacement by other sources of protein could take place, such as novel products and inventions in the food sector.

2.2 Resources affected by meat production

The cultivation of livestock for human consumption naturally needs more resources than those of agriculture. In addition to the water and land both need for the production itself, livestock furthermore requires feed, which in return requires more land and water to grow. This significantly enlarges the ecological footprint of meat production (Dagevos and Voordouw, 2013). Despite that, a limited number of livestock can still make a positive contribution to the ideal usage of resources, since their diet often, at least partially, includes for humans non-edible biomass, and thus can contribute to food availability by feeding them on these marginal resources (Erb et al., 2012). While in most developing regions, the majority of harvested crops is directly used for human consumption, in industrial countries the number of crops used for livestock feed often outweighs the directly consumed amount (Di Paola et al., 2017), and the tendency for this trend is rising with the GDP (Erb et al., 2012). This is in line with large-scale intensive livestock systems being mostly prevalent in industrial and emerging economies (Di Paola et al., 2017). Due to the scale of these systems requiring large amounts of feed, livestock feed becomes more and more the focus in agriculture, instead of being a way to utilise marginal resources.

The consumption of enough protein is necessary for a healthy diet, but it can be covered by both animal or plant sourced protein (Aiking, 2011). The meat sourced proteins are superior to the plant sourced ones in quality and utilisation, but not by a wide margin (Walker et al., 2005). While through intensive breeding domesticated animal species have already improved feed conversion efficiency (Erb et al., 2012), it is still low enough to make animal source protein considerably more ineffective than plant sourced one (Dagevos and Voordouw, 2013; Aiking, 2011; Walker et al., 2005), with a conversion rate of on average calculated to be about 15-21% (Di Paola et al., 2017). Consequently, the majority of plant sourced proteins in feed are still wasted for human utilisation. This results in the conclusion that direct consumption of plant protein being in most cases the more effective choice to provide the majority of protein in food for the population.

The various animal species used for livestock have different dietary requirements for their feed, but are split into two main groups: Monogastric and ruminant species. Pigs and poultry make up the most common monogastric species cultivated as livestock, while the ruminant category is primarily comprised of cattle, sheep and goats (Erb et al., 2012). Monogastric species are primarily fed products that could be directly consumed by humans, while ruminant species graze (Erb et al., 2012; Smil, 2002), which puts their feed in less direct competition to human food. However, Monogastric species are more efficient at converting plant protein to animal protein and thus require less feed intake per output (Aiking, 2011).

2.3 Benefits and Challenges of meat reduction

For the vast majority of people, their diet includes both meat and plant-based products. But while plant-based products are necessary for a healthy diet, meat is not vital (Walker et al., 2005). Too high shares of meat in the diet instead increase the risks for a variety of health issues, such as heart diseases or cancer (Di Paola et al., 2017; Erb et al., 2012; Aiking, 2011; Godfray et al., 2015; Walker et al., 2005). A reduction of meat intake in the diet of especially people in industrial countries where more meat per person is consumed than in developing countries, could thus have a positive impact on the overall health status of the population. The inverse, however, is true as well, in developing countries where a significant share of the population suffers from various nutritional deficiencies, adding moderate amounts of meat to the diet could be advantageous (Dasgupta, 1997; Walker et al., 2005).

While the benefit of utilising marginal feed resources was already mentioned as a potential of small-scale livestock farming, an additional kind of resources gained from livestock would be non-food ones such as leather or bones (Erb et al., 2012). A further potential problem of meat production on the other hand, lies in the spread of animal-borne diseases brought upon by the close contact of animals in livestock productions and the then fatal spread of resistant bacteria (Aiking, 2011). This is yet another risk that is primarily present within intensive livestock systems.

A key challenge of the reduction of meat lies in the general cultural significance of meat in most nations. Consumption of meat is generally seen as an affluent and desirable dietary choice (Dagevos and Voordouw, 2013; Erb et al., 2012). Despite the generally known environmental impact of meat production, most people still choose to consume meat, although some observations show that there may be potentials to elicit a reduction to some degree (Dagevos and Voordouw, 2013).

Another major benefit from a reduction of meat production is the environmental impact of the livestock sector. Animal products, particularly beef and sheep meat, lead to greenhouse gas emissions higher than the production of plant-based foods (Nordgren, 2012). While it is not a primary driver in comparison to other sectors such as energy or transport, this difference in emissions still holds mitigation potential (Sadik-Zada et al., 2019). Additionally, while keeping small quantities of livestock can have a positive effect on the environment as sources of fertiliser and soil conditioner, intensive livestock systems contribute to erosion and pollution (Erb et al., 2012).

This strong environmental impact also leads into the food security issue of meat production. Since more resources are needed than for agriculture, and utilised resources get degraded to some degree, the logical consequence is that to feed more people from the same or less usable area, plant-based foods are the obvious choice. Livestock keeping would then only making a positive contribution to food security if it is conducted on a less intensive scale. Particularly industrial nations could thus benefit from reducing their livestock sector in favour of using the area currently needed instead for growing feed to gain more agricultural products for direct consumption. This has the potential to increase food security, both in the middle and longer term, as well as making the diet of these countries healthier and more sustainable. Being able to produce a greater share of the consumed food domestically in a country within the same area, furthermore leads to a lesser dependency on imports, at least for staple foods.

2.4 Current situation in Germany and Potentials for Improvement

The recommended daily amount of protein consumption according to the World Health Organization is $62.25 \text{ g capita}^{-1} \text{ day}^{-1}$, if average body weight is assumed to be 75 kg (Di Paola et al., 2017). Yet, in industrial nations the average daily protein intake is usually much higher. One result of that is obesity existing as a major problem in this group of countries (Erb et al., 2012). Cutting protein intake down to the recommended level, would therefore not just provide no problem for the nutritional integrity of the dietary needs, but even improve it. The average protein intake in Germany in 2019 was $104.24 \text{ g capita}^{-1} \text{ day}^{-1}$ (FAO, 2019). A reduction to the WHO recommended level would thus equal cutting it down by 40.28%.

In the following calculations an autarky situation devoid of imports and exports is assumed. Furthermore, only the three species of livestock most commonly kept in intensive farming

systems in Germany, namely pigs, cattle and poultry, are considered. Reducing the current meat production by the same percentage as the protein intake, in favour of the then released agricultural output being used directly as food instead of animal feed, would lead to a significantly higher supply of nutrition.

Regarding the conversion efficiency from fed plant matter into animal matter, various researchers have calculated differing rates. This is only natural, since the usability of feed depends heavily on factors such as specific breed of animal, type of feed or living conditions the livestock is kept in (De Boer and Aiking, 2011). In order to illustrate the range of possible rates better, the following calculations use separate assumptions of conversion efficiency from two different authors, called Case a) and b). Case a) assumes a very low conversion efficiency of just 10% across all three species (Godfray et al., 2010). Case b) assumes separate, significantly higher conversion efficiencies based on the species: 25% for pigs, 14% for cattle and 50% for poultry (Walker et al., 2005).

Table 1. Livestock Reduction Potentials.

	Pigs	Cattle	Poultry	Total
Current Livestock Production (Head)	53,378,000	3,281,000	670,742,000	729,093,000
Current Livestock Production (kg)	4,740,400,000	1,130,200,000	1,806,600,000	7,677,200,000
Livestock Production after reduction (kg)	2,830,966,880	674,955,440	1,078,901,520	4,584,823,840
'Conserved' amount of Livestock (kg)	1,909,433,120	455,244,560	727,698,480	3,092,376,160
Surplus of Agricultural yield; reduced meat production (kg) Case a)	-	-	-	30,923,761,600
Surplus of Agricultural yield; reduced meat production (kg) Case b)	-	-	-	12,279,841,360
Additional edible matter (kg) Case a)	-	-	-	27,831,385,440
Additional edible matter (kg) Case b)	-	-	-	9,187,465,200

Source: FAO (2020).

These results suggest that even with the highest assumptions for conversion efficiencies, there are substantial potential gains to be found in meat production reduction strategy. The additional nutrition, even subtracted by the lost amount of meat, would be higher than the entire current livestock production in Germany. When considering the lower assumed conversion efficiencies, it would be even more than triple the amount of the current livestock. Such increases would at the very least contribute to an increased food supply and therefore a greater level of food security, which consequently results in less dependency on imports. In the best case, these increases could even play a role as a new export good. The assumption of higher and, most critically, varying conversion efficiencies as in Case b) further suggests the idea that maybe not all livestock should be equally reduced, with poultry appearing significantly better in their conversion efficiency than pigs and especially cattle.

These simple calculations show at first glance a quite drastic potential for an increase in available plant-based food. However, taking into account all the previously identified benefits, there are several further aspects that would need to be taken into consideration in a real-world scenario. Firstly, cattle could also be fed almost exclusively on grazing (Erb et al., 2012), and the grassland plains used for that can often not effectively be converted into agricultural land needed to grow crops consumable by humans. This puts their feed requirements in theory into less of a direct competition for human food.

Secondly, without the autarky assumption, especially under the aspect of free trade within the EU, it is likely that a reduction in domestic production would at the very least in the short and medium term be met with a sharp increase in meat imports. Since this bypasses the environmental, public health and food security gains a reduction is supposed to bring, it makes

the option of independently reducing meat production in Germany from the supply side less attractive. Especially for imports from outside the EU it might even worsen both animal and human health aspects, due to potentially less strict regulations on livestock keeping in other countries. This consequently results in the conclusion that a reduction in meat production is an endeavour that would need to be addressed globally or at least on an EU level, to be carried out in a truly effective way.

Thirdly, while before these calculations no assumption was made about whether consumer demand would change, it seems at first glance unlikely that it would happen so drastically on its own, given the in 2.3 mentioned attributes of meat consumption as a desirable dietary choice. Dagevos and Voordouw (2013) however, have shown via an empirical study in the Netherlands that a significant share of consumers had already started to reduce the frequency in which meat is consumed about a decade ago, yet not necessarily affecting the total amount. The same study furthermore suggests that the preference of meat products may not be as rigid as previously assumed, especially for certain groups of consumers and in the presence of specific alternatives. These alternatives are mainly not plant-based products, but non-meat animal products such as cheese or eggs (Dagevos and Voordouw, 2013). While other animal products still exhibit a higher environmental footprint than purely plant-based ones, non-meat animal products are more effective in their production than beef and pork (Di Paola et al., 2017). This preference revelation shows that there may be a certain receptiveness amongst consumers to a change in their diet. Due to the mentioned issue of potential reductions purely on the supply side likely being met with a rise in imports, a demand reduction seems like a complimentary necessity to really elicit a change in the use of meat.

There would be two main categories of policies to induce a change in consumer behaviour toward the desired effect of less meat consumption. Dagevos and Voordouw (2013) see soft policies such as engaging and exemplifying as the more effective strategy, with strong policies being not completely discarded, yet seen as the secondary choice. Their proposals include raising public awareness of the negative aspects of meat consumption, or the promotion of meat alternatives, such as subsidizing one vegetarian day a week in public institutions. As a key factor they identify that policymakers and politicians need to steer the focus of the public more towards the necessity of meat reduction, to keep the topic relevant in their minds.

Nordgren (2012) on the other hand argues in favor of stringent policies as the main driver, specifically a meat tax, but without a complete neglect of soft policies. He advises that soft policies will not be enough and a differentiated EU tax on meat consumption would be necessary to make a lasting impact on consumer behavior. For that, he proposes to tax consumption instead of production due to the high monitoring costs of a production tax. A consumption tax, however, would be easy to implement and could induce a fast change in the average diet. As a further advantage of this taxation, he identifies a potential reduction of meat production in countries exporting to the EU.

Walker et al. (2005) provide a third option, namely the increase of wages in the farm and meat sectors. If those industries received better payments, it would naturally raise the price of meat as well, to match the costs. This, along with higher standards in meat production seems like a further option to reduce the amount of intensive livestock production, along with probably increasing the quality of the produced meat.

3. CONCLUSION

All in all, the endeavour of meat reduction seems to be one with great potential. A complete abolition of all meat production would be neither feasible nor recommendable. However, scaling down the currently too intensive livestock systems in industrial countries to a lower level would come along with a wide variety of sustainable benefits such as climate and environment protection, human health, and food security. In Germany, a reduction of meat production down

to a level that would follow the recommendations the World Health Organization suggests for a healthy diet has the potential to free a significant amount of land currently used to harvest animal feed, and instead use as agricultural land for direct production of human food. This sharp increase in available nutrition would increase food security in Germany and consequently self-sufficiency, due to lower reliance on imports. Various approaches exist of how exactly such a transformation of the average consumer diet can feasibly be achieved. There are different judgements of what should or could be the primary and most promising method, but there is a consensus that not just one policy alone, but a combination of it should be used in the end. Nevertheless, the first step should be to make policymakers aware of the necessity to deal with the question of how meat production should be treated and regulated in the future.

Author Contributions: For research articles with several authors, the following statements should be used “Conceptualization, M.N. and E.R.S.-Z.; methodology, M.N.; validation, E.R.S.-Z., L.Y. and M.N.; formal analysis, M.N.; writing—original draft preparation, M.N., L.Y. and E.R.S.-Z.; writing—review and editing, E.R.S.-Z.; supervision, E.R.S.-Z.; project administration, E.R.S.-Z. All authors have read and agreed to the published version of the manuscript.”

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

List of References

- Aiking, H. (2011), Future protein supply, *Trends in Food Science & Technology*, 22 (2-3), 112-120.
- Dasgupta, P. (1997), Nutritional status, the capacity for work, and poverty traps, *Journal of Econometrics*, 77(1), 5-37.
- De Boer, J., & Aiking, H. (2011), On the merits of plant-based proteins for global food security: Marrying macro and micro perspectives', *Ecological Economics*, 70 (7), 1259-1265.
- Dagevos, H., Voordouw, J. (2013), Sustainability and meat consumption: is reduction realistic?', *Sustainability: Science, Practice and Policy*, 9 (2), 60-69.
- Di Paola, A., Rulli, M. C., Santini, M. (2017), Human food vs. animal feed debate. A thorough analysis of environmental footprints, *Land Use Policy*, 67, 652-659.
- Erb, K. H., Mayer, A., Kastner, T., Sallet, K.E., Haberl, H. (2012), The Impact of Industrial Grain Fed Livestock Production on Food Security: an extended literature review, Commissioned by Compassion in World Farming, The Tubney Charitable Trust and World Society for the Protection of Animals, UK. Vienna, Austria.
- Federal Office for Agriculture and Food (2020), *Statistics*, https://www.ble.de/DE/BZL/Daten-Berichte/Fleisch/fleisch_node.html [accessed: 30.06.2022].
- Food and Agricultural Organization (FAO) (2019), *Statistics*, <https://www.fao.org/faostat/en/#data> (accessed: 30.06.2022).
- Food and Agricultural Organization (FAO) (2020), *Statistics*, <https://www.fao.org/faostat/en/#data> (accessed: 30.06.2022).
- Godfray, H. C. J., Beddington, J.R., Crute, Ian R., Haddad, L., Lawrence, D.; Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., Toulmin, C. (2010), Food security: the challenge of feeding 9 billion people, *Science (New York, N.Y.)*, 327, (5967), 812-818.
- Nordgren, A. (2012), Ethical Issues in Mitigation of Climate Change: The Option of Reduced Meat Production and Consumption, *J Agric Environ Ethics (Journal of Agricultural and Environmental Ethics)*, 25, (4), 563-584.
- Sadik-Zada, E. R., Loewenstein, W., Hasanli, Y. (2019), Commodity Revenues, Agricultural Sector and the Magnitude of Deindustrialization: A Novel Multisector Perspective, *Economies*, 7(4), 113. <https://doi.org/10.3390/economies7040113>
- Smil, V. (2002), Worldwide transformation of diets, burdens of meat production and opportunities for novel food proteins', *Enzyme and Microbial Technology*, 30(3), 305-311.
- Walker, P., Rhubarb-Berg, P., McKenzie, S., Kelling, K., Lawrence, R. S. (2005), Public health implications of meat production and consumption', *Public Health Nutrition*, 8 (4), 348-356.