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The shift from meat to plant-based proteins: consumers and public policy

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A reduction in meat consumption would be desirable to promote sustainable diets. Globally, meat consumption is still increasing, and the various meat alternatives introduced in recent years occupy only a small share of the meat market. Since technological solutions alone are not sufficient to reduce meat consumption, policy measures and interventions are discussed. We describe various measures that have been proposed to reduce meat consumption. Based on the evidence from the literature, some of these measures are unlikely to be effective (e.g. labeling) or acceptable to consumers (e.g. taxes). It will be important to focus on measures that are effective (e.g. nudging). However, since consumers tend to be resistant to fundamental changes in their diet, rapid transitions cannot be expected.

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Introduction

Because of the industrialization of agriculture and the globalization of the food market, a rapid upscaling of highly intense industrial meat production systems has become possible [1]. This development has resulted in increased meat consumption worldwide, and meat production is still growing [2]. A low animal protein diet is usually not the result of a voluntary decision to adopt it but rather is driven by a lack of financial resources [3]. As a result, the projected growth in global meat consumption is largely driven by income and population growth

[2]. In developed countries, which typically have relatively high levels of meat consumption, some scholars, non-governmental organizations, and policymakers have advocated for a reduction in meat consumption as meat production can cause environmental problems and animal welfare issues [4]. However, thus far, changes in the amount of meat consumed have been modest at best [2].

Two different strategies could be employed to facilitate a transition from an animal- to a plant-based diet. Meat can be substituted with plants high in protein, such as legumes. However, such a strategy would require that consumers replace some of their frequently consumed, highly valued traditional meat-based dishes with novel dishes for which meat is not needed. This would require not only cooking skills and new cooking practices but also an openness to accepting new dishes in one's diet. Fewer changes in food preparation are necessary if meat portions are reduced or if meat is replaced by plant-based meat analogs. In recent years, the food industry has introduced myriad meat analogs on the market that mimic different types of meat (e.g. burgers and sausages) and various animals (e.g. beef and chicken). Today, these products occupy only a relatively small niche market [5].

Another strategy would entail replacing red meat with meat that is associated with a reduced environmental impact. Insects [6] and cultured meat [7] have been proposed as substitutes for traditional meat. These high-protein and novel, albeit animal-based, foods should help to reduce the environmental burden associated with food production and animal welfare issues. However, it is not yet possible to fully estimate the environmental, health, and economic sustainability of cultured meat and insects as food [8]. Furthermore, there is robust evidence that consumers are reluctant to embrace insects and cultured meat on their plates [9]. Therefore, significant barriers must be overcome before these alternatives can substantially replace the consumption of conventional meat.

A large body of research has examined the factors that influence the acceptance of different alternative proteins and how consumer acceptance could be increased [9–11]. The initially high degree of growth in the purchase of alternative proteins has resulted in unrealistic

forecasts [12,13]; in recent years, the growth of these products has been lower than predicted [5].

Should governments intervene?

Some scholars have argued that market failures (i.e. prices do not reflect external costs) cause unsustainable food consumption, thereby justifying governmental interventions [14,15]. However, this perspective is somewhat dubious, as it appears plausible that government failures (e.g. subsidies in the meat sector) may even increase meat production. It has been demonstrated in some detail that the European Union, for example, seems incapable of formulating policies related to a transition toward a more sustainable food system across different areas [16].

Interventions aimed at banning meat have met with resistance as meat is not only considered a luxury good that symbolizes economic wealth, but it is also not necessarily unhealthy and is an important source of some micronutrients [17]. Corresponding measures to substantially reduce animal protein consumption may, therefore, have some undesired side effects. People who transition to a vegetarian or vegan diet require knowledge about how to acquire all necessary nutrients. A poorly implemented vegetarian or vegan diet could increase the risk of under- or malnutrition among vulnerable demographic groups, such as babies, young children, or health-impaired persons.

Although eliminating meat from our plates appears to not be desirable, in many developed countries, meat consumption could be reduced without any negative health effects [4]. The following sections will critically discuss the potential of various measures to reduce meat consumption (see Figure 1).

Reducing meat consumption

The most important factor influencing food choice for most consumers is taste [18,19], except for low-income consumers, where price is most important [20]. Therefore, introducing taxes to increase the price of meat could be a tenable strategy to reduce consumption. We are not aware of any study that has observed the impact of taxes on meat consumption in a natural setting; however, in various countries, sugar-sweetened beverage taxes have been introduced. There is only minimal evidence that these taxes exerted a strong effect on consumption, as the reported effect sizes are small, and the quality of most studies is rather poor [21].

Controlled intervention studies in which the 'healthier' products were subsidized have suggested that the products must be 20% or even 50% cheaper compared with the 'less healthy' products in order for a relevant substitution effect to be observed [22,23]. These results

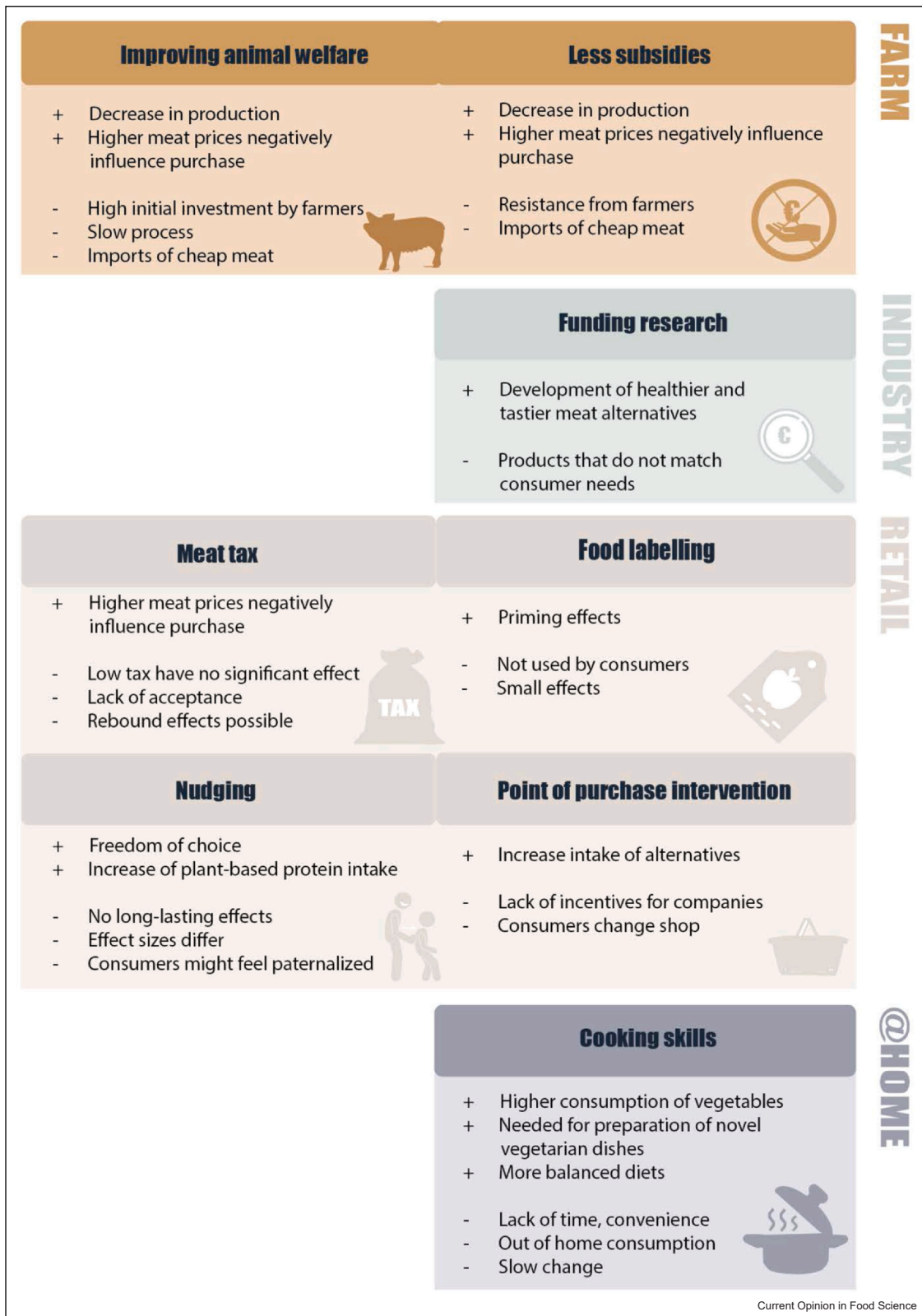
suggest that high taxes on meat would be necessary in developed countries to substantially reduce meat consumption. Realistically, it is unlikely that such high taxes would be accepted by consumers or producers, and politicians would be hesitant to introduce such a tax. Therefore, acceptable taxes on meat would most likely exert a minimal effect on the amount of meat consumed. Furthermore, taxes may also precipitate some unintended side effects that should be considered. If the taxes lead to a reduction in meat consumption and thus a reduction in food expenditures, there could be a rebound effect in which more sustainable food consumption is replaced by increased consumption in other areas [24].

Labeling is a less intrusive intervention compared with taxes, and it has been more enthusiastically accepted by consumers [25]. Similar to nutritional information, sustainability information could be communicated on food packaging. A front-of-package ecolabel might not only provide information but also prime consumers in the purchase phase to take sustainability into consideration. However, an experimental study in which participants had to select the more environmentally friendly product demonstrated that such an ecolabel only marginally increased consumers' accuracy in selecting environmentally friendly foods [26]. Although few studies have examined whether ecolabels truly influence consumers' purchase behavior, numerous studies have examined the impact of nutrition labels, such as the Nutri-Score, on purchase behavior [27]. Overall, there is no clear evidence that the Nutri-Score leads to a healthier diet. If no relevant effects can be observed with health-related labels, it is unlikely that a label containing environmental information will be any different for the general population.

With stronger interventions, it was possible to influence behavior, at least in the short term [28]. If the climate-friendly dishes were labeled in a canteen, and information regarding nutrition and climate was provided, sales of the more climate-friendly dishes increased continuously for around three weeks. This suggests that interventions could be effective. In such a setting, social control may play a role as well. Therefore, it remains inconclusive how important information and social control were for the effects observed.

The most effective strategy to improve sustainability may not focus on meat consumption but rather on the amount of food consumed. Obesity is responsible for increased mortality [29]. In developing countries where meat consumption is high, reducing caloric intake will decrease both the incidence of obesity and the environmental impact of the food consumed [4]. Success in promoting healthy diets might therefore be a strategy that could lead to reduced meat consumption as a by-product. In that vein, a 'demeatification' of convenience

Figure 1



Possible effects of different interventions to reduce meat consumption.
 Note: Image nudging adapted from [Flaticon.com](https://www.flaticon.com).

food products, dishes, and out-of-home food would be desirable [1]. This would not only result in lower meat consumption but could also reduce the caloric value of many foods.

Reducing meat production

The meat and dairy industries are heavily subsidized [30]. As a result, meat prices do not reflect the cost of the products, and meat is artificially cheap compared with plant-based proteins. Rather than calling for taxes on meat or subsidies for plant-based proteins, subsidies should be reduced as much as possible so that food prices better reflect the costs associated with production. Subsidies may also send a signal to the public that meat is important, which may conflict with nutritional advice to limit meat consumption for health or sustainability reasons. Furthermore, most animal production systems are considered ethically problematic by consumers [31]. There are trade-offs between animal welfare considerations and cost-effective production methods. A greater emphasis on animal welfare may therefore not only be an ethical imperative but may also result in higher production costs, which may lead to higher prices and lower consumption. Such a strategy may not be easy to implement, as changes in subsidies or meat production systems are likely to be resisted not only by farmers but ultimately by consumers as they realize that meat will be more expensive.

Increasing plant-based protein consumption

Rather than decreasing meat consumption, perhaps plant-based protein consumption could be increased [32]. Such a strategy will only be effective, however, if consumers do not increase their overall protein consumption. The concept of nudging has been introduced by Thaler and Sunstein [33], who proposed that choice environments can be designed so that people select what is best for them or for society even if the number of options does not change. The results of a meta-analysis suggested that creating substantial effects through healthy eating-related nudging may be difficult because the overall effect of nudging appears to be relatively small [34]. However, it should be emphasized that nudging interventions have varied considerably across studies. Interventions that made healthier options easier to choose, used them as the default, or placed them earlier in a cafeteria line exerted substantially larger effects than the provision of information, for example. Therefore, certain nudging strategies might be useful to increase the consumption of plant-based proteins rather than animal-based proteins.

Cooking skills are necessary to prepare appetizing vegetables. It is therefore not surprising that cooking skills are positively associated with vegetable consumption and negatively associated with meat consumption [35]. A

lack of knowledge about how to prepare plant-based meals has been found to be a barrier preventing the shift toward a more plant-based diet [36,37]. Mandatory cooking classes in schools and public cooking information campaigns could be a means to increase not only vegetable consumption but also the skills needed to prepare a healthy and tasty meal. This could help familiarize children with plant-based foods, and it could also help to preserve traditional meals that are part of a society's culture.

Improving plant-based meat alternatives

Research into meat alternatives has flourished in recent years [38]. However, the products available still do not meet the expectations of many consumers. By definition, meat alternatives attempt to mimic the taste, texture, and functionality of meat. While functionality works for simpler processed meat products (e.g. burgers and sausages), the taste and texture of meat alternatives are still regarded as significantly inferior compared with meat [39]. If meat alternatives are substantially more expensive than meat, this is another barrier preventing their wider adoption.

Given the shortcomings of meat alternatives in the marketplace, we strongly believe that more research is needed to further improve meat alternatives. Despite several large European projects such as SMART PROTEIN (<https://smartproteinproject.eu>) or GIANT LEAPS (<https://giant-leaps.eu>), many open questions remain. In addition to advances in processing methods to produce better-tasting meat alternatives, this research must be complemented by consumer insights. Only by understanding the situations in which consumers wish to use meat alternatives and what drives their purchase decisions will product development be successful. It is still an open question whether meat alternatives should mimic meat in taste, texture, nutritional value, color, or functionality. While consumer research has focused on some of these aspects, we need to better understand how much each of these factors contributes to the acceptance of meat alternatives. In addition, research should examine what trade-offs consumers are willing to make if only some of these aspects were to be imitated. Finally, there is a lack of sensory studies that show which factors are most important for consumer acceptance of meat alternatives. This research requires a longer horizon than many food companies can afford. Therefore, research grants will be important to conduct the basic research necessary for product development.

Conclusions

Scholars tend to agree that further increasing meat consumption worldwide is associated with negative consequences for the environment and animals. As a result, scientists are not only working on novel protein

products [7,38] but also proposing various measures to help instigate a transition from an animal-based diet to a plant-based diet [14]. In this paper, we have discussed many different interventions, and some are simply unlikely to be effective or accepted. Such a result may sound disappointing to some, but we believe that we should focus on the most promising interventions and not invest resources in interventions that are unlikely to be effective.

People tend to be conservative when it comes to their eating habits, and even if they are somehow motivated, they find it difficult to change their eating habits [40]. Therefore, quick changes must not be expected. Many scientists claim that meat consumption must be reduced and that urgent action is needed [14,15]. It is important to remember that this is not necessarily a scientific decision but a political one. We are always faced with trade-offs and uncertainties when we discuss the benefits and risks associated with our current meat consumption. Depending on the weight given to the benefits or risks, different choices can be made. Therefore, a top-down process of dictating what people should eat will likely fail.

Improving not only the taste and texture of meat substitutes but also their nutritional value is important for broader consumer acceptance. This should be complemented by research that estimates the substitution effect of these products. It is frequently assumed that increasing the consumption of plant-based meat alternatives will automatically reduce meat consumption. While this sounds plausible, there is only weak evidence, based on correlational data, that the consumption of meat alternatives reduces meat consumption [41]. However, the magnitude of this substitution effect is unknown. Therefore, despite all the research concerning the acceptance of meat alternatives, little is known about how important they are in reducing meat consumption.

We are skeptical about the effectiveness of environmental impact labels or taxes. The limited effect of these measures has been demonstrated in relation to influencing various consumer groups to buy healthier foods. Consumers' personal benefits are even lower when it comes to the environmental impact of food, and other consumption motives are likely to overshadow environmental considerations [18]. Therefore, we do not believe that labels indicating the environmental impact of foods or taxes on meat will be important measures in the transition to a more plant-based diet. At the same time, we believe that food production subsidies should be reduced and that animal welfare standards should be raised. Both of these measures would better reflect the true costs of products. This would increase the costs of animal protein relative to plant protein and should result in the reduced consumption of animal protein.

A lack of cooking skills is frequently a barrier to transitioning to a more plant-based diet. Therefore, cooking classes at school could be important not only for the transition to a diet with more vegetables and plant-based protein but also for a healthier diet. Improving the skills necessary to prepare appetizing meals or convenience foods without animal proteins is also important in the training of chefs. Otherwise, it is unlikely that meat consumption in cafeterias or takeaways will be reduced. Some nudging interventions also appear to be effective [34] and could contribute to the increased consumption of plant proteins; however, more research is needed to better understand which nudging strategies work and which do not.

Scientists may agree that meat reduction is desirable [4], but they should be aware that such a view is not necessarily shared by the general public. A backlash against meat substitutes should be expected, as meat production and processing are not only economically important but also entangled with cultural traditions. What we eat is related to how we define ourselves [42,43]. Agriculture not only produces food but also shapes the cultural landscape and provides rural employment. Cultured meat, for example, could be perceived as a threat to jobs and culture in economically depressed areas, which could further fuel opposition to this technology.

So far, farmers and their organizations in different countries have responded differently to the introduction of meat alternatives. One reason is that they also see business opportunities in these alternatives [44]. Another reason could be that the market share of this novel sector is still relatively small compared with the meat market, and no immediate threat is perceptible. If meat alternatives will be viewed as a threat to meat producers, some reactions are to be expected, since meat alternatives have some evident weaknesses. We expect, for example, that the healthiness (or lack thereof) of meat alternatives will be more heavily questioned in the future. Furthermore, there may be a greater focus on the ultra-processing aspect of meat alternatives, since ultra-processing has been blamed as a risk factor for consumers [45].

There is no silver bullet for reducing meat consumption; rather, a variety of measures are needed to achieve this goal. We have delineated some of the actions that could contribute to a more sustainable diet. Equally important, we have demonstrated which measures are unlikely to be effective and thus should not be pursued. A holistic view of the entire agri-food chain is needed. Otherwise, changes may not reduce environmental impacts but rather increase them. This could be the case if meat substitutes are consumed in addition to meat, rather than replacing meat. Another example could be that sausages are substituted, but not more valuable cuts, and

less valuable parts of the animal are no longer used for human consumption. It is therefore crucial that policies aimed at reducing meat consumption are carefully evaluated.

Data Availability

No data were used for the research described in the article.

Declaration of Competing Interest

The authors do not have any conflict of interest.

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- of special interest
- of outstanding interest

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