

VEGANIZING ANIMAL FOODS

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There is no question that the projected growth of meat production is intimately associated with many ecological issues. It is safe to predict that meat sustainability and ecology are on a collision course. The huge requirements of fresh water, particularly for meat-producing animals, could eventually have a catastrophic impact on the environment. The world needs to make hard choices and will, at some point, be forced to accept a diet with less traditionally harvested animal protein, and instead move to precision fermentation technologies in which gene expression is used to produce cultured meat and milk proteins, as well as embrace molecular agriculture for food security.

Emissions: A Beefy Question

Carbon dioxide emissions from energy and transportation currently take the largest share of climate pollution. On the heels of energy and transportation come the emissions from agriculture, which will continue to increase to keep pace with the significant projected growth of global meat and dairy consumption. It will be necessary to address these increases because, without adequate implemented actions, nitrous oxide from the field and methane emissions from livestock could double by 2050, if not sooner.

A New Food Outlook

Soybeans, pea and faba pulses, wheat and potatoes

are emerging as potential host "micro biofactories" that uses metabolic engineering genetic techniques to grow proteins, such as meat proteins and ovalbumin (egg protein). This technology is part of the truly innovative molecular agriculture, allowing resource efficient sustainable production that is resilient in diverse climates and compatible with existing harvesting methods. The technology is based on inserting a DNA sequence into the plant genome and when appropriately expressed will significantly grow and increase the adopted protein source. High-scale production of animal proteins in plants can be considered a form of veganizing animal protein ingredients that has the potential to transform the traditional protein-generating industry economically and sustainably. For example, cultivating pork proteins in soybeans or ovalbumin in wheat is a new way forward to guarantee future food security, while maintaining sustainability as well as providing superior nutritional and organoleptic performance properties such as texture, gelling, and emulsification (Moolec Science).

The transition from animal to plant-based proteins need to accelerate. However, making consumers eat more legumes and pulses is easier said than done. Despite the good intentions to eat fewer animal protein-containing foods, the animal-to-plant ratios remain unbalanced. A complicating issue is that consumers should also be encouraged to consume

less (highly) processed food products. For farmers, it is generally difficult to grow profitable crops for the regional or local market, which results to mostly imported plant crops in many developed countries. All these variables delay a faster trajectory to eating more sustainable plant protein-formulated foods.

Consumption of minimally processed natural fresh foods, including vegetables, fruits, and meat snacks grew by 25 percent from 2004 to 2024. Looking at it from a different perspective, about half of food and beverage consumption now occurs when consumers are alone, not to mention that in affluent single person households -projected at about 32 percent in 2024- are at the highest level in history. The trend of eating solo is likely to grow in the years ahead.

For centuries, meat and meat products have been the center of the plate to supply protein and nourishment. At the turn of the century, however, a seismic shift has occurred; meat-formulated snacks, cheese, egg, and yogurt are now considered the preferred animal protein containing food choices. The young generation of consumers clearly have a different mindset when it comes to mainly eating steak-size meat portions, dairy and eggs as their prime source of protein. An increasing number of these consumers partly replace meat and dairy with plant protein formulated alternatives, or hybrid foods in which meat or dairy is reduced or

used as a component rather than a dominant plate-filling source.

Name Calling

Descriptive names such as vegetarian meat, plant meat, alt-meat, fake meat, and analog meat has become a marketing nightmare to educate consumers how to define the “meatless meat” category. In short, the category can be summed up as breaking down plants to transform the protein to animal-like shaped meat analogs. Plant-based eating doesn't have to mean entirely

flexitarians has greatly increased over the years. As more research is published on the benefits of a flexitarian diet, demand in the alternative food category is expected to grow. Most dieticians agree that incorporating one nutritionally balanced plant-based meal a day into the diet improves overall health. The number of flexitarian consumers is growing much faster than vegetarianism and veganism. It is estimated that in developed countries and affluent societies, about 60 percent of people now eat meat-free meals at least once

than exclusively eating plant foods, most flexitarians prefer the “indulgence” of dairy proteins or occasional animal meat for superior taste and flavor that cannot be completely replicated in fully plant-formulated foods. Most flexitarians are not willing to compromise on taste, texture, and flavor of plant-based foods. As a result, hybrid solutions might ultimately become the preferred food category, like blended combinations of meat protein components and soy-, or pea- or oat protein that provides great organoleptic quality, while maintaining the nutritional values they feel comfortable with, such as the wildly successful McDonald's “McDo Burger” in the Philippines. This McDonald's menu-board product is world's best-selling hybrid burger made from a small part of beef enhanced with soy protein granules. As a matter of fact, McDonald's is well on its way promoting hybrid meat products -a technology that was introduced to them in 1994 by the writer of this article. This timeline shows how difficult it is to transform traditional and conventional thinking and replace with food-forward technologies.



cutting meat, eggs, and dairy, nor does it mean sticking to a vegan dietary intake. For most consumers, it simply means that plant food options now allow diversifying beyond traditional choices and categories.

A large part of the flexitarian consumers are urban-living non-vegetarians of upwardly mobile populations that may likely purchase plant meat foods and plant-formulated milk. The number of people identified as

a week. The UK and Germany are the largest retail markets for plant-based food in Europe. Both legacy food companies, as well as newly established startups, have joined in tandem to strive for a reduction in environmental footprint associated with livestock farming and aligning with the growing consumer demand for sustainable food choices.

Flexitarian consumers are not really bothered sticking to a strict plant-based diet. Rather

Time to Act

Sustainability is emerging as an important issue for affluent young generations of consumers, and as such, it can be anticipated that pressure is mounting on food manufacturers to act accordingly. On their end, food retailers and quick service restaurants encourage or demand their suppliers to step up efforts to -ultimately- become carbon neutral by setting net zero targets to reduce emissions in line with the Paris agreement. To accomplish these hefty goals,

concrete actions are needed to transform the global food system by addressing issues such as hybridization, biodiversity, transparency, climate smart food production, food waste, plastic waste reduction, as well as extended shelf life of perishable vegetables and fruits while preserving their “naturalness”.

The consumer landscape is changing rather quickly, especially with the younger generations driving change in areas such as “clean and green labels” with natural and pronounceable ingredients. This powerful emerging group of consumers is looking for meals or snack foods with less or no preparation time and/or deliver instant gratification. However, they also want foods to fit a holistic wellness that is perceived as foundationally nutritious. Especially in affluent societies, differentiating lifestyle foods for specific consumer segments is becoming the new normal. In many developed countries and affluent societies, consumers are abandoning the three meals a day routine for smaller non-defined meals and snacks. Many of these food choices qualify as better-for-you snack options and are a welcome choice for busy singles and parents that lack time in their daily schedule. Within this framework, increasingly “heat & eat” and “ready-to-eat” chilled or frozen foods are chosen.

It is expected that the young generations will adjust their diet and include more sustainable food choices, including embracing the plant-forward movement. Plants will be playing a meatier role. It is important to know that consumers are steadfast in their expectations and that repeat

purchases of plant-based meat and plant milk brands depend on meeting or exceeding these expectations.

A Moving Target: US Dietary Guidelines

The new US dietary guidelines (2020-2025) backed off from strict sodium rules, reverse previous guidance on the dangers of dietary cholesterol, and add new advice to cut back on added sugar. Apart from these guidelines, the new dietary advice can be summarized as an environment-friendly diet, lower in red meat and processed emulsified meats, and de-emphasizing the role of lean meats in the list of proteins that are part of a healthy dietary eating pattern. As a strategy to increase the variety of protein foods, consumers are advised to increase consumption of seafood, vegetables, fruits, seeds, and nuts.

About 60 percent of EU, UK, and US adult citizens are living with one or more diet-related chronic diseases. Without much needed critical dietary reforms, it will be difficult to reverse the current obesity and high blood pressure epidemic that is causing immobility, prolonged pain suffering, and early deaths. Most affluent dietary guidelines are not compatible with global health and environmental targets. Science-based guidance, not dietary fads that have a habit of frequently changing, is critical to ensuring a healthy future across a person’s lifespan. It is a fact that the typical western citizens overconsume total energy, saturated fats, sodium, added sugars, as well as alcohol beverages. Although there is a slight reverse in vegetables and fruit intake, the consumption

of fruits, vegetables, nuts, and whole grains are generally lower than the recommended dietary guidelines. Together with these lower consumptions, there is also an underconsumption of calcium, vitamin D, dietary fiber, and potassium, which can be seen as a significant public health concern. Furthermore, there is a growing number of vegans who suffer from vitamin B12 deficiency.

It should also be noted that reducing saturated fat intake and replacing it with unsaturated fats -particularly polyunsaturated fat- lowers the incidence of cardiovascular disease in adults by decreasing serum of total and low-density lipoprotein cholesterol. However, the latter science is debated in new scientific dairy studies which have concluded the benefits of dairy foods on chronic disease risks at all fat levels.

Observational Proof

Dietary-induced health benefits of food is usually discussed only when looking at large populations. There is little doubt that food and health are hotly debated talking points that certainly seem to add to public consternation over dietary advice, which appears to change every few years. Dietary reversals can be compared to a revolving door -- no wonder consumers are easily confused about what and what not to believe. Just mention the words protein, salt, carbohydrates, or fats and the conversation goes nowhere. Moreover, there is also a growing awareness about the sustainability of agricultural crops monoculture and environmental degradation caused by livestock production, which tends to have

an outsized climate footprint partly because of all the land needed to harvest animal feed for raising cattle, farm pigs, and feed chickens and quickly bring to slaughter weight.

It is estimated that on average, beef has about five times the climate impact of chicken or pork, calculated per kilo net protein contribution to the human diet. Add to that the cow's methane emissions

and transparent on how they plan to tackle the reduction of greenhouse gas emissions.

The United Nations says the global livestock industry is responsible for 14.5 percent of the world's anthropogenic greenhouse gas emissions, majority of which comes from cattle ranching. These emissions are also associated with the high levels of deforestation in Latin America, Africa, and

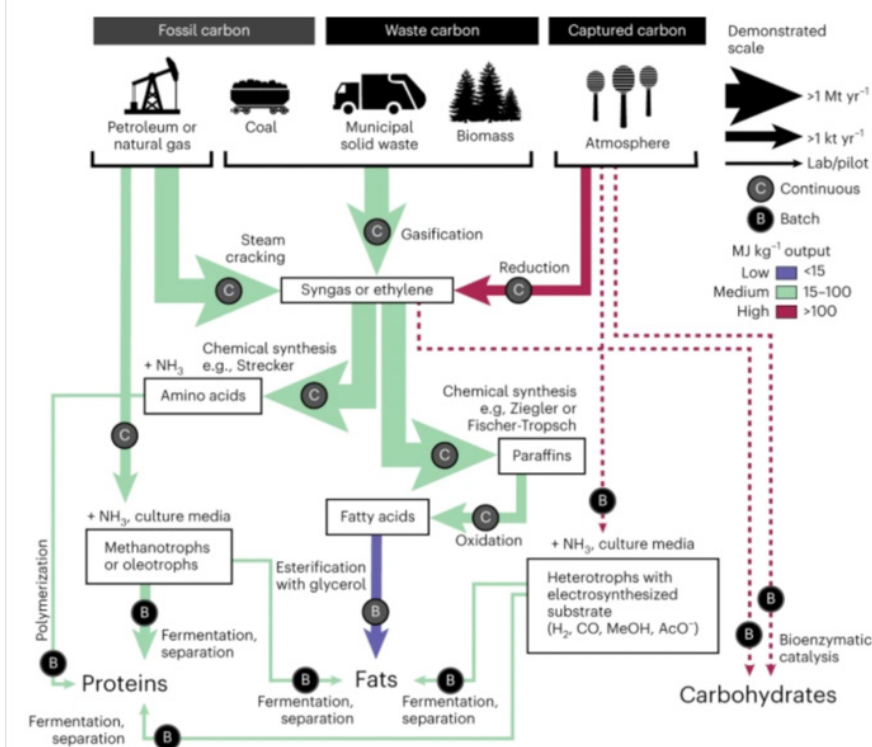
Another assumption highlighted that if less meat consumption is compensated with increased plant-based nutrition, healthcare costs will go down. This assumption could be based on wishful thinking and have not yet been proven on large groups of people.

Meat Rules Protein

At the global level, beef production and consumption continue to grow as incomes rise across the developing world. For comparison: pork consumption stayed relatively constant, whereas consumption of chicken more than doubled. The consumption numbers are still higher than the official dietary recommendations in developed countries. For example, in the Netherlands no more than 26 kilos of total meat consumption per person per year is recommended. This translates to about 70 grams of (processed) meat per day, with no more than 40 grams coming from "red meat" such as beef, pork, and sheep. In the developed countries, the average meat consumption has been rather steady over the last decennia. Hence, it can be concluded that the true protein transition has not yet happened.

Shifts in meat consumption occur in both developed and developing markets. The US, UK and some EU affluent countries have a negative growth (-1 percent) as poultry wins shares of the consumers' stomachs at the expense of beef and pork. Some of the declines in meat consumption are not only due to health concerns, religious and sustainability issues but also because of consumers embracing or adopting a different diet and lifestyle, as well as increased prices for lean meat options.

synthesize food without agriculture.



- a very potent greenhouse gas. Agriculture is one of the main sources of emitted methane and nitrous oxide, primarily from livestock. More than 90 percent of the corporate dairy industries' emissions are produced by the cows themselves, mostly in the form of methane. Unfortunately, on a global scale, minimal public pressure currently exists to force large legacy food, dairy, and meat companies to become proactive

Asia. The same United Nations report predict that with the world's population expected to climb further, meat consumption will rise exponentially in the years ahead.

In the hierarchy of the meat pyramid, beef takes the number one spot of having the highest environmental costs per kilo of meat followed by pork, while poultry has the lowest costs.

In contrast, growing meat consumption in developing countries and emerging markets will push the global market to a volume growth of 2 percent in 2024 with no signs of stopping any time soon. Meanwhile, poultry has emerged as the most popular meat protein in the world, increasing by 4 percent per year in volume growth.

It is noteworthy that flexitarians who regularly enjoy a “veggie” meat alternative at home will often choose to eat meat when dining out. The consumers’ relationship with meat in their diets is changing. There is a subtle shift in consumers’ perceptions about the nutritional and health contribution of meat. Although it is true that affluent consumers are more aware of the importance of high-quality dietary protein, they increasingly look away from meat, and instead, prefer seafood options or non-meat foods. This development should set off an alarm for the meat industry.

There are multiple reasons as to why meat consumption is steadily in slow decline in affluent societies. For the aging population, health and convenience are usually cited as the main reasons, while the sub-30-age group is often in a different lifestyle mode with meat playing a less dominant role as center-of-the-plate food. In addition, the twin effects of time-pressed lifestyles and tight budgets are the main reasons that consumers living in affluent societies are shifting away from traditional home-cooked center-of-the-plate, whole muscle-meat cuts, and switching to semi- or fully prepared natural, wholesome dietary-sound options. It is therefore no wonder that

meat is increasingly looked upon as an ingredient or as a small part in a side dish.

Key risks to the meat industry include increased cost of energy

the growth of alternative protein-formulated foods.

However, to be fair and balanced the double-digit growth of plant meat sales came to a crashing halt



(electricity) due to carbon pricing, higher costs of animal feed due to demand and/or poor crop yields, and increased livestock mortality due to heat stress, as well as increased costs for clean water processing and its recycling. The potential downside risks for meat companies are the physical impact of climate change and

in 2022, a fact demonstrated by plant meat companies going into administration and consolidation.

“Sustainability Tax to Promote Health”

Thoughts are trending that the world is slowly moving towards a slaughter-free future. This

might be a utopian belief; fact remains that governments in some affluent or developed countries are actively trying to flatten the curve of meat consumption. A “sustainability charge”, not a “meat tax”, is one of the options to be instilled to reflect its environmental costs, including CO₂ emissions and biodiversity loss. All this will be done to encourage and incentivize the consumers to increase the consumption of plant-based foods. An often-heard argument is that animal agriculture is the leading cause of climate change, species extinction, deforestation, habitat loss, pollution, and diversion of clean water needed for human use.

Water and GHG

Agriculture consumes more fresh water than any other human activity, and nearly a third of that water is used for raising livestock. One-third of the world's arable land is used to grow feed for livestock, which is responsible for about 14,5 percent of global greenhouse gas (GHG) emissions. Long-term agricultural greenhouse gas emissions are clouded by two main uncertainties:

- How does livestock production and consumer preference for meat and dairy cope with much-needed yield improvement to meet rapidly growing demand?
- How fast do human dietary requirements and food preferences change?

Emissions are closely interrelated with agricultural land, manure management, crop yield, genetic livestock improvement, as well as possible climate change and water availability. As stated, agriculture

accounts for approximately 14,5 percent of greenhouse gas emissions globally, including emissions from mechanical farm equipment, plowing and planting, manure management, feed cultivation, and field burning. It is likely, however, that artificial intelligence applications and the use of robotic vehicles, will level or possibly reduce the amount of greenhouse gas that is associated with agriculture.

Conventional beef production by means of raising animals for a rapidly rising world population requires enormous levels of energy, feed, and water expenditure. These factors are damaging the ecological environment and will, ultimately, prove to be unsustainable. When extrapolating 2020 baseline knowledge to 2050 feed and food availability, it can be concluded that the projected increase of ruminant meat and dairy consumption will not be able to keep emission levels within agreed targets, unless major technology improvements are implemented. Hence, based on today's state of technology, it can be predicted that meeting climate targets may require future forced reduction of meat and dairy production and consumption. For optimal dietary health, this means an increase in per capita consumption of animal-derived proteins in the developing world and a much-needed decrease in developed or affluent societies. However, realistically speaking, this is not going to happen anytime soon.

The obvious solution is to develop improved genetics of livestock and embrace cell-cultivated meat, insect protein extraction, and great-tasting plant meat

foods, as well as hybrid foods characterized by animal meat and plant protein combinations. Consumers should be encouraged to eat more plant-based protein foods not only to improve their nutritional status, but also to proactively relieve the unrelenting increase of world's demand for slaughtered meat and overreliance on traditional dairy.

Protein: Rebalancing of Alternatives

When it comes to plant protein, consumers have a lot to choose from. Globally speaking, soy protein is by far the largest source of valuable plant proteins. Also, alternative sources like pea protein, faba protein and mycoprotein are gaining traction. There is no question that the harvest needs to transform plants into premium and sustainable protein foods to nourish the world. Preferably, this must be accomplished keeping the protein as natural as possible, i.e., minimizing the use of harsh chemicals to concentrate or isolate the protein, as well as looking at alternative methods like dry fractioning and embracing precision fermentation, and molecular agriculture. These new technologies together with plant protein ingredients, like those derived from legumes, pulses, cereals, vegetables, and fruits are will ultimately allow true transformation into functional and nutritional, cost-effective ingredients in a plethora of food products. Good protein should possess a handful of properties and characteristics: stellar nutrition, great flavor, texture, color, processing adaptability, versatility, and performance in more ways than one.