Global Veganism

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Globally, diet patterns are changing due to culture dilution, agricultural trade policies and other variable factors. Amongst these patterns are veganism and vegetarianism which are not the same. Vegans completely avoid all forms of animal flesh and products from them. Vegetarians may consume some products with varying reasons, ranging from ethical and health to religious beliefs.

livestock production | crop production | food policies | Climate change | veganism

1. Merits and Demerits of Global Veganism

Clarification between veganism and vegetarianism is important, as vegans and vegetarians alike do not consume meat (neither flesh nor organs). Vegans completely avoid all forms of animal flesh and products from them. Vegetarians may consume some products with varying reasons, ranging from ethical and health to religious beliefs. Regardless of the form of meat avoidance or said products, a hypothetical shift from stopping meat production leaves only dairy (a form of livestock production), layer-poultry (monogastric production), and crop production as the major surviving sectors from current agricultural production.

Assuming the world went strictly vegan, it would mean no form of livestock or ruminant production. Methane is one of the most produced gases in the livestock sector and is a key driver of climate change, as enteric fermentation occurs in ruminant livestock. Enteric methane is a short-lived climate pollutant with a lifespan of 12 years (in comparison to CO_2, parts of which stay in the atmosphere for many hundreds to thousands of years). Methane traps 84 times more heat than CO_2 over the first two decades, after which it is released into the air [1].

There are over 352,814 species of plants [2], of which approximately only 7000 species are used for food. In addition, 75% of the world's food is generated from only 12 plants and five animal species [2], while only three plant species—rice, maize, and wheat—contribute nearly 60% of the calories and proteins obtained by humans from plants. Since the 1900s, some 75% of plant genetic diversity has been lost, as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties, a biodiversity issue often neglected. Animals provide some 30% of human requirements for food, and 12% of the world's population live almost entirely on products from ruminants [3].

On the global level, meat consumption continues to increase, but a contrary trend, mostly in developed nations, reveals increasing relative consumption of plant-based proteins by three main segments of consumers. First, there are 75 million people who choose freely to follow a vegetarian diet and are likely to increase in number [4]. This group is mostly motivated by their care for animals, health, and environmental reasons [5]. Secondly, a relatively small group of vegan consumers (e.g., 0.5% in the USA) is mostly motivated by deep concerns about the food system, and their population is projected to grow [6]. Thirdly, there is an absence of empirical data to strongly back those whom experts identify as so-called 'flexitarians', who consume less meat without completely abandoning it [7][8] for a variety of reasons.

Most proponents of global veganism are of the view that humans need to directly consume plants that already contain proteins rather than cycle it. There are, however, proteins from some leguminous plant families that humans cannot consume readily due to high contents of toxic alkaloids [9] and other toxic compound allergens but can be metabolized by animals as feed. A study by Coluccia and others [10] found that soy drinks (non-diet alternatives) could be a full substitute for cow milk, as their production had a lower C footprint; however, to achieve the same nutritional value as 1 L of cow milk in terms of protein intake, the consumption of soy drinks needed to be increased by 13%. Moreover, according to the same study, consuming soy drinks meant paying 66% more than for cow milk for the same protein content. Approximately 1.5 billion people in developing countries follow a vegetarian diet because they lack resources to purchase meat [4].

According to a study conducted by Souza and others in 2020 [11], non-vegans who were considering going vegan stated reasons involving the avoidance of exploitation of animals, (cruelty, confinement, torture, and killing). The respondents also commented that veganism had positive effects on the environment and climate.

2. Health and Nutrition: Vegan Versus Conventional Diet

Choices of agricultural products have a direct relation to health. The greatest number of deaths globally, particularly in developing nations, can be attributed to dietary risk factors associated with imbalanced diets high in red meat content [12]. A study conducted by Springmann [13] and others found that climate change may lead to reductions in global food supply, fruit and vegetable consumption, and red meat consumption by 3.2%, 4.0%, and 0.7% per capita, respectively, by 2050. These changes were associated with 529,000 climate-related deaths globally, representing a 28% reduction in the number of deaths avoided due to changes in dietary and weight-related risk factors between 2010 and 2050. Globally, the population of vegetarians and vegans in the general population follows an increasing trend, somewhat due to evidence that vegetarianism is linked to improved health [14], and this may be related to anticarcinogenic measures and reduced risk for cardiovascular diseases. However, plant-based diets have low contents of essential micronutrients, such as iron, zinc, vitamin B-12, vitamin D, omega-3 (n-3) fatty acids, calcium, and iodine, and such micronutrient deficiencies lead to the risk of malnutrition. People who follow vegan diets usually are required to take daily supplements of some of these nutrients because the averages of these nutrients are insufficient in their diets. Although some sources of plants can compensate for the required amounts of nutrients, vegans need to consume 20% more food than non-vegans (omnivore) to arrive at the recommended daily doses of the above-mentioned nutrients [15].

Animal welfare and animal health have no direct relation to critical environmental issues, but it is a controversial topic when it comes to housing and animal discomfort. In addition, resistant bacterial disease is deemed perilous to humans, as this is usually a threat transferrable from animals, especially those kept in closed systems. It is recognized that meat choices are persistent and are based on stable preferences and positive feedback mechanisms at the individual, social, and economic or organizational levels [16]. However, it is possible that a society simultaneously experiences a trend toward vegetarian and vegan diets in some segments, with a trend toward rising meat consumption in others [17].

3. Socio-Economic Implications of Global Veganism

There is no doubt that livestock is a big investment, regardless of the system of management. The livelihoods and food security of over a billion people are directly dependent upon livestock [18][19]. This is subject to change due to change in variabilities, such as the COVID-19 pandemic and the ongoing Russian–Ukrainian war, amongst other naturally occurring and anthropogenic factors. The plant-based revolution promises a cleaner climate because it has the tendency to reduce GHG emissions, as well as to reduce the incidence of animal exploitation and provide cheap sources for human nutrition. To safeguard this revolution, there is a need to create early warning systems and policies to monitor and swiftly control plant pest and disease endemics. This is because of the consideration of certain crops, such as rice, which is cultivated in 100 countries, supports nearly half the world's population, and is at risk from multiple vector-transmitted viruses at a cost of USD 1.5 billion annually [20]. In addition, the cacao swollen shoot virus (CSSV) has become endemic in Ghana, Nigeria, and Togo. West African cacao production accounts for 70% of the world's cacao supply. The loss of cacao plantations would devastate the local economy and lead to global cacao shortages, and expensive eradication programs have been established to save the cacao industry [21]. To add to the importance of livestock production, all those involved along the value chain of animal products gain indirectly from livestock production. Animals provide food and nutrition, as well as raw materials for industries, and contribute to the GDP and foreign exchange. For example, the USA produces nearly $330 billion annually in agricultural commodities, with contributions from livestock accounting for roughly half of that value [22]. A graphical representation of beef production in the various regions of the world from 2009 to 2019 shows that much revenue is generated from the Americas (48%) and Asian (21%) countries (**Figure 1**). A discontinuity in production would spell a gross economic contraction for the USA, Brazil, Argentina, and mainland China as the top four producers over the last decade.

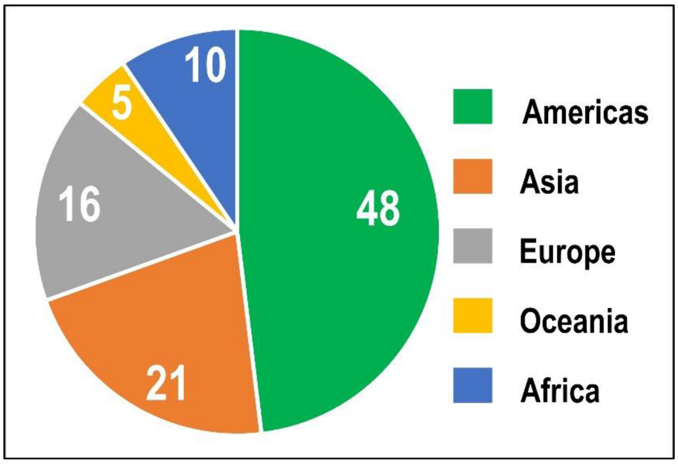

Figure 1. Average cattle meat production by region from 2009 to 2019 [23].

It is difficult to precisely measure livestock contribution to total household income; however, some studies showed that livestock's average contribution ranged from a low 7% in Panama to a high 37% in Pakistan, and usually fell between 20% and 30% [23]. Although this contribution may not be very high, it is a more resilient option against crop failure. By improving communication and interpretation of livestock evidence, today's polarized views might be replaced by a more constructive dialogue concerning livestock's role in humanity's future [24]. In the quest for 'quenching the thirst' of agriculture, irrigation systems have quickly replaced dependency on rainfed agriculture. Precision irrigation coupled with advanced weather and water monitoring systems is the prime alternative to overexploiting the currently available water resources [25][26].

Yield gaps, which are the difference between current yields, as well as prevailing environmental factors, and what could be achieved under better pest control, water, and nutrient management, are lowest in regions where risk factors are easily manageable, i.e., principally in developed countries. For the future, existing areas where large yield gaps exist are the greatest opportunities for meaningful gains (e.g., developing economies), although this could lead to over- or misuse of technologies (such as irrigation, fertilizer use, etc.), destroying vital land resources and, thereby, compromising ecosystem services. If the livelihoods of small-scale farmers are improved, they are in a better economic position to adopt new technologies and contribute to the global economy [27]. For instance, biofortification is considered a sustainable strategy to alleviate nutrient deficiencies (malnutrition), increase farmers' income, and ensure food quality and safety by improving nutrient contents in crops through plant breeding and genetic engineering [28][29]. Recently, it was confirmed that the cropping of a biofortified rice (e.g., DRR Dhan 48 variety) could result in Zn-enriched rice grains and a better cost–benefit ratio due to the reduced consumption of agrochemicals and the higher price of such a product [29].

4. Environmental Risks of the Veganism Paradigm

Agriculture has been altering and impacting pristine ecosystems, but never as drastically as now. Areal expansion of agriculture and intensification of agricultural practices are the two main threats that potentially contribute to land degradation [28]. Annually, the loss of ecosystem services due to land degradation represents a reduction of 10–17% of the global GDP [27]. Several interventions have been made to curb the threat of unregulated and improper agricultural practices that impact the environment negatively. Drylands are an essential source of land, and they contribute to more than 40% of the world's cropped areas. By continent, they comprise as little as 16% (South America), and more than 70% (Australia and Oceania) [24][28].

Rainfed agriculture provides lower investment costs but unreliable patterns in rainfall necessitate farmers to find solutions and more continual sources of water. New satellite technologies have shown that the largest declines in groundwater are in the major irrigated regions. The inevitable growing competition between irrigation and other water use sectors enhances the threat of water scarcity [27][28]. Worldwide, it was estimated that only 18% of all cultivated land was irrigated, yet these lands produced 40% of all food [30]. Without irrigation, it was estimated that the global production of rice, cotton, citrus, and sugar cane would decrease by 31% to 39% and cereal production would decrease by 47%, representing a 20% loss of total cereal production worldwide [31]. Globally, irrigated agriculture is the prime user of groundwater [32], with half or more (estimated at around 70–80% of total water consumption) supplied by groundwater [33].

In addition, to close yield gaps to meet the global food demand in 2050 requires increased applications of N (45–73%), P (22–46%), and K (200–300%) compared to 2010. The global total quantity of NPK fertilizer used on croplands reached 172.2 million metric tones in 2010–2011, of which 60.5% was N-based. The global average fertilizer consumption is 138 kg/ha; however, many agroecosystems do not use mineral fertilizers [25], while in others fertilizer consumption can reach >500 kg/ha [34]. Most gains in production are projected to come from fertilizer and water [28], but this still does not warrant productivity, as there are several biophysical elements that come into play to increase yield. To shift from dependency on industrial fertilizer (inorganic), the uses of animal manure, compost, green-manuring, and nitrogen-fixing bacteria have been adopted amongst other technologies to increase gains [25][35][36]. In large commercial farms, however, the use of agrochemicals appears to be easily applicable, as most farm implements are designed to handle such products, although manufacturers are regularly developing new implements to match with new innovations. Inorganic fertilizers may pose a pollution problem in areas without any farmer compensation or strong agricultural policies compared to cases of areas in the EU due to the Nitrate directive [25].

However, as part of the shift to ‘green farming’, orphan crops and other wild relatives of crops may be at risk, as they may not be of commercial interest, leading to a decline in biodiversity [25][36][37]. This may be true if the economic returns in a plant-based revolution yield profit in areas close to centers of diversity. Regarding biological and genetic integrity, wild relatives of plants and orphaned crops should be kept in situ to enable further research in plant breeding and other scientific advancements. Some current cultivars that take a lot of resources to breed might also be neglected for economic reasons.

Soil as a resource is usually undermined with salinization and alkalinization as major threats to the soil resource globally [35]. This is especially valid in drylands due to their erratic rainfall, high evapotranspiration rates, and wide presence of soluble salts [35][38]. Developed countries may often apply excess amounts of fertilizer that can carry heavy environmental consequences, while poorer communities often face a net depletion of soil nutrients that threatens sustainability, economic viability, and food security. Without fertilizer application, yields can be sustained for short periods only because the productivity consumes pre-existing stocks of soil organic nutrients. Increased use of fertilizer is important to avoid further land degradation by nutrient depletion but must also be accompanied by a substantial increase in the efficiency of their use [25][39]. Drylands are centers of agricultural development, a territory of plant domestication and an important in situ genetic-conserving territory, but dryland production will be a challenge in the future [40].

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