IJASD
ISSN 2618-1193

Impact Assessment of Climatic Variability on Agricultural Productivity

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Citation | H. H. A. Raja Rizwan Javed, Abdul Baqi, Qammar Shabbir Rana, "Impact Assessment of Climatic Variability on Agricultural Productivity," *Int. J. Agric. Sustain. Dev.*, vol. 4, no. 3, pp. 91-104, 2022.

Received | July 14, 2022; **Revised |** July 26, 2022; **Accepted |** Aug 04, 2022; **Published |** Aug 10, 2022.

In light of the latest research on climate change, a growing number of people are advocating for a worldwide shift to veganism to help lessen the impact of this impending ecological disaster. Animal agriculture has been criticized for allegedly being a major source of greenhouse gas emissions. However, other studies have found that livestock farming may contribute less to GHG emissions than previously estimated, suggesting that eliminating meat from the diet (i.e., moving to a vegan diet) can reduce global GHG emissions. Natural resources, biodiversity, and economies are all predicted to be directly impacted by a paradigm shift in agricultural production. However, relying solely on crop production and a vegan diet may cause serious issues with agricultural crop residues, land and water scarcity, and the loss of important plant and animal genetic materials. This "all eggs in one basket" strategy could affect international meat trade, alter the course of some economies, and put the nation's food supply at risk in the event of a widespread outbreak of pests or diseases. This review found that the integrity of future land and water resources may be threatened by crop-based ideology, but that this ideology would make a significant contribution to lowering GHG emissions. Food security, consumer preferences, environmental protection, and a fair income for farmers around the world all necessitate the development of appropriate instruments within agricultural policies. All agri-food industry players, from government officials to farmers, should work together on a unified plan to lower the carbon footprint of our food supply while also safeguarding the (agri)environment and ensuring stable incomes.

Keywords: Farming Practices, Food Risk Management, Climatic Variability, Food Security

Introduction

The global population of people who choose to abstain from eating meat and other products derived from animals (vegans) is growing, but only at a slow pace. This trend, which is only slightly on the rise, is most pronounced in Westernized nations and regions where people have access to a variety of food options. In particular, rising per capita income over the past half-century has coincided with a worldwide trend towards a diet that is more heavily focused on animal products (milk, meat, and eggs), with nearly 3 billion people predicted to fall into the "luxury/meat-eating" or "dairy-based food" categories by 2030 [1]. However, the significant impact of the COVID-19 pandemic and the Russian-Ukrainian war on agri-food and diet trends has been overlooked by many of these forecast scenarios. There is no way to know if and when the economy will return to normalcy, so this fact must be taken into account when making new projections. Climate change and other environmental factors add new levels of complexity to the farming process. A climate-safe farming program must take into account both the level of knowledge and the willingness to adopt a technology.

Recent agricultural developments have highlighted the importance of implementing environmentally sound and economically lucrative food production systems that also protect the local ecosystem and cut down on harmful greenhouse gas emissions. Targets, resources, costs, government regulations, and farm locations all play a role in how farms implement their agricultural systems [2]. Population growth and related variables, such as migration and shifts in consumer preferences due to incomes and policies, are expected to have the greatest impact on global agricultural commodity demand between 2020 and 2030[3]. The world's population and incomes are projected to increase by 70% by 2050, necessitating an increase in food production of up to 100% by then. As a result of climate change, farmers face production risks such as unpredictable rainfall patterns, droughts, and pest and disease buildups. More than 80% of the food produced worldwide comes from rainfed agriculture and natural grasslands used to feed animals, and all farming today is dependent on the repercussions of climate change being mitigated. Affected the most are small-scale producers and indigenous farmers in developing countries where crop insurance is either unavailable or prohibitively expensive. Nonetheless, it should be remembered that agriculture is a contributor to GHG emissions; some estimates have its worldwide share at 13.5 percent by 2007.[4]. The productivity of crops and animals may rise in the mid- to high-latitudes while falling in the tropics and subtropics as a result of climate change. The difference in income between developing and developed nations may widen as a result of this. But as agricultural land use has increased over the years (mostly at the expense of deforestation in tropical regions, marginal areas, or less desirable areas), agriculture has been accused of destroying related ecosystem services, lowering biodiversity, upsetting hydrological regulation, and emitting even more greenhouse gases.)[5][6].

Since this is the case, there is a growing group of eco-activists who believe that the world's population should stop consuming meat and other animal products in order to reduce their impact on the climate (i.e., go vegan). Particular attention has been paid to the livestock industry as a key contributor to greenhouse gas emissions and a crucial factor in lowering global warming. For instance, one study concluded that agriculture has a negative impact on the environment and that eliminating meat from the global diet would reduce greenhouse gas emissions by 49 percent, or 6.6 billion metric tonnes of CO2eq. This review presents and discusses plant-only agricultural production as a possible answer to this problem.

Effects of Climate on Productivity

Because of the effects of changing biotic pressures, agricultural products and livestock are especially susceptible to climate change. Although there are many plans in place to combat climate change, the threats have only increased over the past 40 years and are expected to worsen over the next 25. The degradation of soil and water supplies caused by global warming is a major threat to farming methods that rely on rainwater. In any agricultural system, failure to implement new ideas and techniques for soil and water conservation is a surefire way to ensure failure [7]. Adapting crop production methods is essential as the climate continues to shift. Climate change's effects on food production are already problematic, and the world's growing population is just making the situation worse. Because of the predicted one-third rise in the global population by 2050, it was estimated that agricultural production would need to increase by 60% to meet the anticipated demands for food and feed. Conventional agricultural practices are less sustainable since they rely on the use of agrochemicals, which can be harmful to the environment and contribute to global warming.

Everywhere in the world, people are waking up to the potential negative health effects of consuming food that was produced using outdated, unchecked methods. Consumers who worry about their impact on the planet and their own health are the most likely to spend their money on organic goods. Just 1.5% of farmland is devoted to organic farming, with the majority of that land in Oceania. In 2018, there were 186 of these countries.

Europe (3.1%), and China (8.6%). However, only about 1.2% of farmland was managed organically across all of the Americas, North America, Latin America, Asia, and Africa in total [8][9]. The terms "organic farming" and "ecological agriculture" imply resource-conserving and climate-resilient agricultural practices[10]. As a result of their potential to benefit both humans and the natural world, many groups and organizations around the world have joined forces to spread awareness about and support such systems[11]. The finding that regenerative fields can achieve 29% lower grain production but 78% higher profits compared to conventional corn production systems highlights the importance of soil health conservation. Soil quality was found to have a positive effect on earnings (not yield). Researchers found that the effects of climate change on crop yields varied by region in a global modeling study of agricultural production at scale. Between 2050 and 2100, yields were predicted to rise in the North by 15%, while they were predicted to fall by >30% in sub-Saharan Africa, Southeast Asia, and large parts of Latin America.

Plants are affected by a wide range of biotic variables, including carbon dioxide (CO2), oxygen (O2), solar radiation (SR), day length (DL), precipitation (P), temperature (T), nutrients (N), and many others. It stands to reason that a given plant type (C3, C4, or CAM) has an optimum range for growth and development, as climate change can easily promote stress and disruptions in any stage of a plant's growth, from germination to fruiting formation and mortality. Increasing temperatures hasten plant maturity in greenhouses, but the soil may not be able to keep up with the increased demand. The size of the plants, the amount of grain, forage, fruit, and fiber produced, and the amount of fiber produced, are all diminished. Extreme temperature swings, both above and below the ideal range, have a deleterious effect on livestock. Both the type of management system used and the rate at which things change have a significant impact on the productivity of livestock systems (measured by things like feed conversion ratio, animal live weight, and economic viability) [12]. Nomadic livestock in an African agroecosystem is frequently subjected to temperatures above 39.5 degrees Celsius, which has been shown to have deleterious effects on reproduction. Changes in the dynamics of follicular growth in the ovaries, poor corpus luteum development, and stunted endometrial growth in the uterus are just some of the negative outcomes. Another known cause of piglet mortality is temperatures below the optimal range during parturition. Metabolic disturbances, oxidative stress, and immune suppression are all made worse by heat waves and can lead to infections. The health, growth, and reproduction of animals, as well as the prevalence of diseases and pests, are all influenced by the varying weather patterns that are characteristic of modern times.

While farmers can feel the heat of climate change firsthand, their greenhouse gas emissions are also a major contributor to the problem. The conversion of vast forested areas to arable lands, especially cash-crop plantations, has a direct impact on the regulation of water and energy fluxes. Changes in the biophysical properties of the surface caused a local warming of 0.23 0.03 C between 2000 and 2015, as reported by Cherlet and others [1]. This warming was caused primarily by agricultural expansion into tropical forests. Livestock and rice cultivation are directly responsible for the predicted 35-60% rise in nitrous oxide (N2O) emissions by 2030 [13][14]. Because of their reliance on natural processes and agricultural practices, these emissions are trickier to regulate and quantify. However, agriculture and forests that are managed effectively can act as "sinks" and make significant contributions to climate change mitigation.

Just three human activities—the burning of fossil fuels (35% of all CH4 emissions), the creation of waste (20%), and agricultural practices (40%)—are responsible for more than half of all CH4 emissions[15]. 32% of the emissions from livestock production come from manure and intestinal fermentation, while 8 percent of all human-caused carbon dioxide equivalents are released as a result of rice farming. A 30% increase in emissions is possible by 2050 if additional mitigation measures and technical efficiency improvements are not implemented. In addition to agriculture's direct, significant contribution (nearly 14 percent) to global GHG emissions, deforestation is a major driver of agriculture, contributing another 17 percent to global GHG emissions. Livestock production causes large amounts of nitrogen dioxide (N2) emissions, which in turn cause biodiversity losses on land and in water [16]. Agroforestry is typically practiced in areas that already have natural forests, and most indigenous people benefit from the biodiversity conservation, nutrient cycling, erosion, flood control, and disease regulation that tropical forests provide.

Related Studies.

It's also important to note that converting farmland to a different use is possible, provided that erosion and the introduction of invasive species are taken into account[17]. Third, the production of livestock has a significant impact on climate change. Nomadic pastoralists and industrial farms both play important roles in the global livestock industry. Rising demand for animal products is responsible for 65% of the change in farmland use over the past half-century, and this demand is expected to grow by more than 50% over the same time period, according to projections. Several factors, including those related to the environment, the economy, and government policies, will determine how plausible this forecast is. Both feed conversion ratios and efficiencies tend to be lower in organic farming systems compared to so-called "conventional farming" [18][19].

For reasons including its possible effects on human and environmental health, animal welfare, and food safety, meat is one of the most hotly contested foods on the planet[20][21]. Livestock raised primarily through grazing production systems is crucial to the food security of poor communities around the world. Livestock keeping is the primary source of food security, investment ('bank on hooves,' literally), and an important source of income in many African countries, especially those with unimodal rainfall or scant precipitation. In the absence of irrigation technology, farmers who practice mixed farming typically grow crops during the brief rainy season and use the leftover residue to feed their livestock until the next rainy season. Livestock production is an efficient means of converting by-products unfit for human consumption because only about 4 percent of dairy products and about 20 percent of beef production are connected to feed that comes from high-nature-value grasslands. As a result of using roughly 5% of by-products that are not suitable for human consumption as livestock feed, animal food production significantly contributes to sustainable food system goals by reducing waste and environmental impacts (Figure 1). Furthermore, only about 13% of the grains and 1% of other edible products used as feed dry matter by livestock worldwide are actually edible to humans (Figure 1).

Environmental issues associated with livestock production include soil acidification, water eutrophication (pollution), and greenhouse gas emissions (38, 40). By depositing nutrients in soils, for example through the use of manure or mineral fertilizers, excessive use can contaminate soils and pollute water supplies through the use of runoff. To put it another way, the amount of N and P in animal manure produced by livestock production is greater than the amount of N and P fertilizer used globally, demonstrating the inadequacy of current nutrient management. By 2030, it is projected that all developing regions of the world will produce a majority of their beef and sheep using landless systems (except sub-Saharan Africa). The problem of agricultural waste can be mitigated to some extent by increasing livestock production. Improved rangeland and pasture growth is a direct result of more sustainable grazing regimes like rotational grazing. Nutrient recycling is made possible by the concomitant consumption of food and the deposition of animal feces. Overgrazing, on the other hand, wipes out perennial grasses, which are then replaced by annual grasses and weedy forbs, some of which are exotic invasive species that accelerate soil erosion [22]. Models show that boosting global crop yields and feed conversion and decreasing food losses across the food chain can have a major impact on easing environmental stress.

For the purposes of this review, it is essential that the distinction between veganism and vegetarianism be made clear, as adherents of both diets refrain from eating meat (neither flesh nor organs). Vegans don't eat or use anything that comes from animals. For moral, health, or even religious reasons, some vegetarians choose to avoid eating certain foods. If we were to hypothetically stop raising animals for food in whatever form that might take, the agricultural industry as we know it today would collapse, leaving behind only dairy (a form of livestock production), layer poultry (monogastric production), and crop production.

There would be no need for livestock or ruminant production if everyone in the world switched to a vegan diet. One of the most prevalent gases in the livestock sector that contributes significantly to global warming is methane, which is produced through enteric fermentation in ruminant livestock. For the climate pollutant enteric methane, its half-life is only 12 years (in comparison to CO2, parts of which stay in the atmosphere for many hundreds to thousands of years). Methane is 84 times more effective at retaining heat than carbon dioxide in the first 20 years after it is produced [23].

There are more than 352,814 plant species [24], but only about 7,000 are cultivated for human consumption. Only 12 plant species and 5 animal species produce 75% of the world's food, with 3 of those species (rice, maize, and wheat) providing nearly 60% of the calories and proteins obtained by humans from plants. As farmers around the world have abandoned their diverse local varieties and landraces in favor of genetically uniform, high-yielding varieties, we have lost about 75% of plant genetic diversity since the turn of the century. About one in three meals consumed by humans comes from animal sources, and 12 percent of the global population relies almost exclusively on ruminant products [25].

Meat consumption is rising around the world, but a countertrend is emerging, especially in developed countries, where three types of consumers are increasingly favoring plant-based proteins. To begin, the number of vegetarians is expected to rise from its current 75 million people [26]. They are primarily driven by concerns for animal welfare, and human and environmental health [27]. Second, although they make up a small percentage of the population, vegans are increasingly vocal about their concerns about the food system and are expected to grow in number [28]. Not enough hard evidence exists to support the views of those thirdly specialists who call themselves "flexitarians" because they eat less meat than the average person [29]but haven't completely given up meat.

Most advocates of veganism around the world believe that humans can get all the protein they need by eating plants that already have protein built in, rather than by recycling[30][31]. Proteins from certain families of leguminous plants are poorly absorbed by humans due to their high alkaloid and allergen content but are easily digested by animals. About 1.5 billion people in developing countries choose a vegetarian diet due to a lack of access to meat.

Coworkers found that in 2020, most people who were not vegan but were thinking about making the switch gave animal welfare as their main reason for doing so (cruelty, confinement, torture, and killing). The majority of respondents also agreed that veganism was beneficial to the environment and climate[34] [35].

The selection of agricultural products has an impact on human health. Unbalanced diets rich in red meat are a leading cause of death worldwide [32][33]. All the more so in third-world countries. According to a study by Coworkers, the world's food supply, per capita consumption of fruit and vegetables, and consumption of red meat could all fall by 3.2%, 4.0%, and 0.7%, respectively, by 2050. Between 2010 and 2050, 529,000 deaths worldwide could have been prevented due to climate change if people had followed healthier diets and maintained healthy weights. The number of vegetarians and vegans in the general population has been on the rise due to the association between vegetarianism and improved health, which may be related to anticarcinogenic measures and a lower risk for cardiovascular disorders. Due to a deficiency in vital micronutrients such as iron, zinc, vitamin B-12, vitamin D, omega-3 (n-3) fatty acids, calcium, and iodine, a plant-based diet is more prone to cause malnutrition. Many vegans discover that they need to take supplements daily since the typical vegan diet lacks adequate amounts of essential nutrients. While some plant sources can really provide the necessary amounts, vegans still need to consume 20% more calories than non-vegans (omnivores) in order to meet the daily requirements for the aforementioned nutrients[36][37][38].

However, animal welfare and health are controversial issues despite having no direct bearing on pressing environmental concerns, especially when it comes to housing conditions and animal discomfort. In addition, animals, especially those kept in closed systems, can spread resistant bacterial diseases to humans, increasing the risk to the general populace. Meat consumption is driven by ingrained preferences and positive feedback loops on personal, societal, economic, and institutional scales. Even if meat consumption is increasing in some parts of society, vegetarianism, and veganism may be on the rise in others.

No matter the method of administration, livestock is a substantial financial commitment. More than a billion people depend on livestock as their primary source of income and food. Many natural and anthropogenic factors, such as the COVID-19 pandemic and the ongoing Russian-Ukrainian war, could cause this to shift. Because of its potential to reduce greenhouse gas emissions and other pollutants, reduce the use of animals for food and other purposes, and make nutritious food more accessible at a lower cost, the plant-based revolution offers great hope for a greener planet. Protecting this revolution requires the development of early warning systems and policies to keep an eye on and quickly eradicate endemic plant pests and diseases. For instance, multiple vector-transmitted viruses threaten rice, a crop grown in a hundred countries that feed nearly half of the world's population at a yearly cost of $1.5 billion. The epidemic spread of the cacao swollen shoot virus can also be seen in Ghana, Nigeria, and Togo (CSSV). In West Africa, farmers grow 70% of the world's cacao. Because the loss of cacao plantations would have a catastrophic effect on the local economy and lead to global cacao shortages, pricey eradication programs have been established to save the cacao industry. The fact that everyone involved in the manufacturing, distribution, and sale of animal products is directly or indirectly reliant on livestock farming bolsters the importance of livestock production. To put it another way, animals help the economy grow and bring in more money from places like tourism and raw materials. About half of the annual value of agricultural commodities produced in the United States is contributed by the livestock industry alone. Beef production across the globe from 2009 to 2019 is depicted graphically, with the Americas (48%) and Asia (21% of total revenue) accounting for the bulk of the market. Over the past decade, the United States, Brazil, Argentina, and mainland China have been the world's top four producers; a sudden drop in output would have a devastating effect on their economies.

Although it is challenging to quantify the exact percentage of a family's income that comes from livestock, estimates put that number between 20% and 30% [39]. This number ranges from as low as 7% in Panama to as high as 37% in Pakistan. This may not be a substantial contribution, but it is less vulnerable to crop failure. If the evidence is better communicated and interpreted, perhaps the polarized views on the future role of livestock in human society can be replaced by a more constructive dialogue [40]. Irrigation systems have rapidly supplanted reliance on rainfed agriculture in an effort to "quench the thirst" of the agricultural sector. The primary alternative to overexploiting existing water resources is the use of precision irrigation in conjunction with sophisticated weather and water monitoring systems [41].

However, yield gaps—the difference between actual yields and the prevailing environmental factors and what might be obtained under improved pest control, water, and fertilizer management—are smaller in places where risk factors are easily controlled, such as in industrialized countries. The largest future gains are anticipated to emerge in environments where these advantages already exist, even when overusing or improperly using technologies (such as irrigation, fertilizer use, etc.) may deplete valuable land resources and disrupt crucial ecosystem functions (for example, developing economies).

In order to have a greater effect on the global economy, small-scale farmers need higher incomes [42]. Biofortification, which improves crop yields and nutrient content through plant breeding and genetic engineering, is one such strategy that has been shown to be effective in reducing nutrient deficiencies (malnutrition), boosting farmers' incomes, and minimizing food-borne illness risks [43]. It has recently been confirmed that biofortified rice cultivation (using varieties such as DRR Dhan 48) results in Zn-enriched rice grains and a better cost-benefit ratio than conventional rice farming, thanks to the lower agrochemical use and higher price of biofortified rice [43].

While agriculture has always had an effect on unspoiled ecosystems, the current rate of change is unprecedented. Increases in agricultural land use and the use of more intensive farming methods are two of the most significant risk factors for degraded land [42]. Ecosystem services lost each year as a result of land degradation reduce global GDP by 10-17%. Agricultural practices that have a negative effect on the environment have been the target of several interventions aimed at reducing this threat. More than forty percent of the land used for farming comes from drylands. They make up anywhere from 16% of the population in South America to over 70% in Australia and Oceania[44].

Low initial investment is required for rainfed agriculture, but farmers still need to find reliable water sources. According to data gathered by new satellite technologies, the groundwater levels in the most important irrigated areas have been decreasing at the fastest rates. Irrigation and other water-using industries will continue to increase their competition with one another, which will only make water scarcity more likely [45]. Only 20% of the world's arable land is irrigated, but that 20% provides 40% of the world's food. One study estimates that worldwide output of rice, cotton, citrus, and sugar cane would fall by 31%–

39%, and cereal output would fall by 47% if irrigation were not used. Irrigated agriculture is the primary user of groundwater, accounting for as much as half (estimated at around 70-80% of total water consumption)[46][47][48].

Result and Discussion

To close yield gaps and meet the global food demand in 2050, applications of N (45-73%), P (22-46%), and K (200-300%) must increase from 2010 levels. Sixt0.5% of the 172.2 million metric tons of NPK fertilizer used on croplands worldwide in 2010-2011 was nitrogen. The use of mineral fertilizers varies widely among agroecosystems; in some, none are applied at all, while in others it can exceed 500 kg/ha. On average, mineral fertilizer application is just over 130 tons per hectare. Fertilizers and water are expected to account for the bulk of the predicted production gains, but even this does not guarantee productivity because of the many biophysical factors that contribute to yield. Some methods that have been implemented to lessen the use of synthetic (inorganic) fertilizers are animal manure composting, green manuring, and nitrogen-fixing bacteria[49][50].

Large commercial farms may make agrochemical use look easy because most agricultural machinery is built to handle such compounds, but manufacturers are always developing new machinery to keep up with advances in the industry. The potential for inorganic fertilizers to contribute to air pollution is likely to be more severe in regions where agricultural policy is weak and farmer compensation is inadequate.[51][52].

The transition to "green farming," however, may threaten biodiversity by eliminating orphan crops and other wild relatives of crops that are of no commercial interest. If the economic benefits of adopting a plant-based diet are concentrated in areas near major cultural hubs, this may be the case. The biological and genetic diversity of wild relatives of plants and orphaned crops should be protected for future use in plant breeding and other scientific endeavors. Similar financial considerations may lead us to ignore some of today's cultivars that require significant breeding efforts.

Salinization and alkalinization are two of the biggest threats to soil resources all over the world. This is especially the case in drylands, where precipitation is unpredictable, evapotranspiration rates are high, and soluble salts are abundant. Poorer regions have the opposite problem: a net loss of soil nutrients that threatens sustainability, economic viability, and food security, while developed nations may use excessive amounts of fertilizer that have negative environmental effects. Produce can only be sustained for a short time without fertilizer since productivity uses up the organic nutrient reserves already present in the soil. Increased fertilizer use is necessary to stop the loss of nutrients that causes land degradation, but this must be accompanied by a large increase in fertilizer effectiveness. Drylands will be challenging for future production notwithstanding their significance as a site of plant domestication and a crucial in situ genetic-conservation domain[53].

The European Union's Common Agricultural Policy (CAP) is one of the oldest and most successful regional policies in terms of preserving agricultural and environmental conditions (farmers' compliance). For decades, this has served as a model for how to improve farmers' incomes while also increasing food security. Plant breeding, genetic manipulation, fertilizers, and irrigation are just some of the ways that yields have increased. A number of factors influence the rate at which farmers adopt new technologies in Africa, but the continent is experiencing a rapid population increase. Some examples of these are the cost, the impact on the environment, the specifics of the farm, the expertise of the farmers, and the ease with which new technologies can be adopted[54][55].

When all the parties involved who hold, produce, or use various types of knowledge are encouraged to talk to one another and work together, transformational technologies or policies can emerge [56]. United Nations Food and Agriculture Organization claims that livestock has always been an afterthought, with policymakers and development practitioners putting more emphasis on staple crops like wheat and rice rather than high-value agricultural products like fruits and vegetables. Furthermore, technical aspects like animal husbandry, feeding, and disease control have been the primary focus of livestock sector interventions[57][58]. The FAO's "Reducing Enteric Methane for Improving Food Security and Livelihoods" project is motivated in part by the fact that reducing enteric methane through productivity gains is the least expensive option and has a direct economic benefit to farmers. This is due to the fact that the livestock industry is both economically significant and a potentially risky source of greenhouse gas emissions[59][60]. "drive informed livestock decision-making through better use of exist- ing data and analyses" is what the members of the Livestock Data for Decisions (LD4D) community of practice hope to achieve. There are people from all walks of life represented in LD4D, from universities to NGOs to foundations to private businesses. Livestock is an agricultural sector with a wide range of priorities and expectations, resulting in a variety of current and proposed policies with varying costs and timelines. Positive and negative interactions between the livestock sector and sustainable development may seem distinct in many cases, but often linkages to specific SDG targets are mixed [61][62]. This is because the livestock sector and sustainable development are intertwined in many ways. Goal 2 of the SDGs is to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture." While consuming fewer or fewer animal products may help reduce the prevalence of malnutrition and stunting among the poor, doing so in excess can have adverse effects on health.

There are about 72 million farmers who own cattle, so it's important to think about how to compensate them locally for the losses they'll experience if their communities go vegan. Because of the interconnected nature of the global economy, if one country reduces its livestock output, another will increase its output to meet the demand. Rules governing the supply and demand sides must be made openly through multilateral agreements. Limiting the world's hunger might be easier said than done. Mixed costs and advantages in the livestock sector have the potential to stymie sustainable development even in hypothetical circumstances where integrated solutions might succeed. For one thing, it's difficult for farmers (especially rural and small-scale ones) to get rid of cattle in order to take climate action.

In terms of farming, we are gradually exceeding the planet's resource-exploitation capacity. There has been a steady increase in pollution, loss of biodiversity, and vulnerability of water supplies as a result of intensive agriculture over the years. This is especially true of commercial livestock production. In any case, institutions have promoted remediation strategies and increased public awareness thanks to research findings. Making the most of the land that is currently being farmed is essential to increasing agricultural productivity and production to meet the needs of a growing global population. If veganism were to gain widespread acceptance, it would likely lead to a rise in plant-based foods as pastures would be converted into croplands and livestock production would be halted. But the majority of productivity increases are anticipated to result from the use of fertilizers and water. Water quality, soil salinization, and the international water cycle are just a few potential downsides to these choices. Concerns have also been raised about the manufacturing of industrial fertilizers because of their role in increasing atmospheric concentrations of greenhouse gases. Soil productivity relies heavily on hydro resource es, which can be depleted if these resources aren't managed more sustainably. Plants grown for biofuels may aid in the fight against climate change, but their cultivation may have an effect on available arable land.

While organic farming combined with the use of microbes for soil amendment is one option, it may not be possible for many rainfed agroecosystems to adapt to more extreme climate change. There are significantly fewer vegans and vegetarians than there are meat-eaters and omnivores because the plant-only movement is just getting started. The ideology could help reduce GHG emissions and expand access to nutritious food, but it could also threaten food production areas, natural habitats, and water sources. Because a plant pest and disease pandemic during the plant-based revolution could cause catastrophic global food insufficiency and insecurity if not quickly contained, putting "all eggs in one basket" on the issue of food security is risky. The use of synthetic fertilizers and pesticides is prohibited in organic farming and on large areas of nomadic grasslands. Monocultures, on the other hand, are common in many intensive agroecosystems around the world, which poses an additional challenge from the perspective of plant and pest management due to resistance, i.e., increased (ineffective) use of agrochemicals and reduced biodiversity. Therefore, it is possible that the already tenuous situation of excessive agrochemical use will worsen if the entire transition to crop (mono)cultivation is made. Commercial farmers may reconsider their support for the ideology of the global market for vegan products expanding, as this would aid in both climate change mitigation and adaptation. Ideologically motivated legislation in the field of agriculture may require funding for regionally specific adoption resources. Policies that provide adequate compensation and insurance to farmers are necessary, especially in the beginning stages of implementation, due to the high level of uncertainty inherent in crop production. Equitable policy tools, including livestock as a backup and insurance against crop failure, are needed for governments and institutions around the world to realize the plant-based revolution. Scaling up efforts to alter people's perceptions of diet as a tool for combating climate change will take decades. Aware-raising, education, and campaigning are all viable options. Problems like food waste in homes and businesses are significant contributors to climate change and must be addressed. Due to their short shelf life, fruits and vegetables require careful preparation and production planning for vegan and vegetarian diets. Not much is known about whether vegan consumers prefer processed or fresh foods, despite the fact that processing is an option. An all-year supply of freshly harvested produce would necessitate substantial investment in storage facilities (especially in tropical regions) or increased, improved indigenous methods to reduce post-harvest losses.

Conclusions

Adding controversy to an already contentious issue, some have proposed that genetically modified (GM) food could increase productivity and enable some crops to be better adapted to certain agroclimatic zones. More thorough risk analyses are needed by policymakers, and this must first be simulated in some regions of the world if a plant-only-based revolution is to be implemented or globally accepted due to climate change. Plant protection authorities need to conduct extensive research and implement preventative strategies in light of potential (biosecurity) plant disease outbreak endemics, especially polycyclic epidemics and massive insect outbreaks, which could pose threats of famine and hunger (especially in relation to climate change). Maintaining the status quo in food production is best for nature and the climate because different organisms are suited to different environmental conditions and management styles. Increased agricultural output, as well as ecological integrity and mitigation of climate change, could result from more efficient and sustainable use of land and water resources.

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