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Review

Could We Stop Killing?—Exploring a Post-Lethal Vegan or Vegetarian Agriculture

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Abstract: This paper explores both the necessities and the options for an agricultural system in which no animals are killed by reviewing existing literature. It first identifies a causal chain which can be labelled as vegan wave and which might generate a consensus that animals should not be killed for human consumption. By raising issues of nutrient supply, grassland management and beekeeping, the paper shows that vegan-organic agriculture, vegan-conventional agriculture and post-lethal vegetarian agriculture are three options for such a pathway. Yet, many technical and socioeconomic questions still need to be resolved.

Keywords: peaceful agriculture; agricultural systems; slaughtering

1. Introduction

Even before agriculture emerged 10,000 years ago, harvesting of crops and killing of animals had been the two building blocks of organizing human nutrition [1]. However, a lot has happened since then. One relatively recent development in human evolution is a decreasing tolerance for violence; an increasing number of campaigns quantify this tolerance to be developing [2,3], and scholars with a macro-perspective have been describing a more and more peaceful world [4,5]. However, could it happen that this inclination to avoid lethal actions extended to agriculture? That we, as a society, would no longer tolerate the regular killing of animals for food purposes and thus entered a post-lethal phase of farming? While this idea may sound unconventional, it is the first objective of this paper to explain and support the vision of such an agricultural system (Section 2).

Our knowledge about the global impact of livestock production has become considerable. We know that 70% of agricultural land is used to feed livestock [6] and that livestock husbandry causes around 18% of global greenhouse gas emissions [7]. Estimates of the land per person needed for a vegan diet range from 700 square meters to 1400 square [6,8], so it is less questionable that a vegan planet could feed a world population of 10 billion people than it is under the status quo. Springman et al. [9] emphasized the health advantages (in addition to environmental advantages) of a vegan planet. However, what such a vegan planet would look like, i.e., how production would be organized, is surprisingly an unanswered question. The fact that vegan consumption has been elaborated to much greater detail [10–12] than vegan production can be attributed to the fact that the vegan movement has its center in cities, not in the countryside [13]. Therefore, the second and main objective of this paper is the compilation of available knowledge about the main challenges and possible solutions for a post-lethal agricultural system, focusing on the substitution of animal-based crop nutrients (Section 3) and on the use of grassland (Section 4). In addition, we address related issues of beekeeping (Section 5), before we briefly discuss available options for post-lethal agricultural practices (Section 6) and point out remaining questions (Section 7). While the paper is not making any moral argument itself, it should be considered as preparation for a potential society with a consensus that animals should not be killed for human consumption.

2. Driving Factors

2.1. Demand Side

When Singer [14] introduced the concept of animal liberation, he conceded at the time that it sounded "more like a parody of liberation movements than a serious objective". However, instead of being bluntly rejected, Singer's position has become increasingly socially acceptable over the decades since. Whereas Singer followed a utilitarian way of argumentation, Regan [15] soon made clear that a deontological position would lead to even more radical positions: it would not only be unethical to kill animals, animals would, as humans, have the right to live.

Since that time, most philosophers have leaned toward similar results as Peter Singer and Tom Regan [16–18]. As soon as scholars began to rationally analyze our agricultural practices of animal husbandry, they were likely to conclude that these practices were fundamentally unethical. If moderate philosophers did not go so far to demand veganism but rather demanded more animal welfare [19,20], it usually was not so much because they were able or willing to defend the killing of animals, but mostly for strategical and pragmatic reasons. However, the voices demanding that legal personhood should be given to animals so that they are protected from being killed [21,22] and emphasizing how unlikely it is that the killing of animals for meat consumption can be defended on ethical grounds [23,24] have clearly become the dominant voices in the debate.

Swabe et al. [25] in the Netherlands were among the first to ask a representative sample of the population about the legitimacy of killing animals for food purposes, with 6.4% saying No and 14.1% being undecided. Ten years later, a German survey [26] indicated that only 72% of the respondents supported the legitimacy of killing pigs. Riffkin [27] reported that the share of US residents who believe that animals should have the same rights as humans rose from 25% in 2008 to 32% in 2015. Very roughly, it seems that one quarter or third of the Western population objects to the killing of animals for food purposes and that this share is rather rising than shrinking.

Other surveys, as displayed by Wikipedia [28], indicate that around 10% of the population in Western countries follows a vegetarian diet, and much less, perhaps two or three per cent, a vegan diet. This combination of facts leads to the proposed wave of post-lethal agriculture as depicted in Figure 1. The expert opinion does not fully translate to the popular opinion, but the development on the expert side leaves its traces in the general discourse. Likewise, the growing opposition against the killing of farm animals slowly and partially translates into the personal consequence of stopping meat consumption. Yet, only a tiny minority has taken the last step of forgoing the consumption of eggs and milk.

Figure 1. The wave of post-lethal agriculture.

The factor that plays into the hands of post-lethal agriculture is that irrationality presumably plays a large role in the delays between the developments. It is unlikely that the three quarters of Germans in favor of killing pigs have better arguments than most animal ethicists being against it. While the majority of the 28% opposed to killing pigs still eat meat, it will be difficult for them to defend this practice. Similarly, not all vegetarians will face the fact that egg and milk consumption today is still necessarily connected to the killing of animals. In egg production, millions of male chicklets and female chickens are killed [29], and neither dairy cows nor their brothers usually die a natural death. In many cases, it will be impossible to make egg and milk consumption compatible with vegetarians' personal convictions. As Örnebring [30] remarked that the rational-critical debate needs time to gestate, it is likely that these contradictions at least lead in the direction of post-lethal agriculture.

2.2. Supply Side

The market for meat substitutes currently is among the most dynamic segments of the food market. Start-ups [31] and large companies like Nestle [32] are heavily investing in the development of products which are fully crop based but taste like meat. Similarly, egg substitution products entered retail in 2018 [33]. Whereas the high price segment of this market often uses insects as ingredients, which show a good environmental balance [34], the bulk of meat and egg substitutes is made of protein crops such as beans and peas. Other companies use algae to compose fish substitutes [35].

Meat substitution products still need improvement because neither the taste [36] nor the appearance [37] reaches the qualities of meat. However, it is likely only a question of time that this problem can be solved. Not only do companies invest a lot of money in the development of these products, but research is also at the forefront in developing laboratory-grown meat that exactly has the quality of animal muscles [38,39]. Although the price of these products is still prohibitively high, technological progress likely will bring production costs down.

The demand for meat substitutes is still limited to minor consumer segments [40,41]. However, it is easy to see that this is likely to change. Imagine that neither qualities nor costs of meat substitution products would differ from those of meat products. Under these conditions, who could condone the suffering of animals being slaughtered and stick to conventional meat consumption?

It is therefore plausible to ask at which stage of the development of meat substitutes it would be time to enter vegan agriculture for society as a whole. How tasty do products made of yellow peas have to become, how low priced does laboratory-grown meat have to be, in order to make a national or even international decision that the killing of animals for food purposes is a habit of the past?

Even if this very question may be misleading, it is definitely worthwhile to explore what agricultural systems without the killing of animals could look like, a question to be approached in the next sections.

3. Substituting Animal-Based Nutrients for Crops

In a vegan farming system, it is likely that the area covered by maize and barley would shrink, because these crops are mainly used for feed purposes, whereas the area for vegetables and protein crops such as peas and beans would probably be expanded. However, these shifts would not challenge the production system of arable crops as such. The main challenge of vegan agriculture comes from the supply of organic matter to arable soils, which would not come from farm animals in a vegan system. Instead, there are real and potential alternatives to be briefly sketched in the following paragraphs.

3.1. The Biocyclic-Vegan Standard

In 2017, the Biocyclic Network Services issued the first standard for a vegan production system, which they termed “biocyclic-vegan standard” [42]. This standard has since been acknowledged as one of three global organic standards by the International Federation of Organic Agriculture (IFOAM), in addition to the IFOAM standard and the International Standard for Forest Garden Products [43].

The standard refers to the work by Rusch [44,45] and his followers [46,47] about “circles of the living substance”. Biocyclic-vegan agriculture builds on all requirements of organic agriculture but sets two additional conditions. The first concerns the centrepiece of biocyclic-vegan agriculture, which is mature plant-based compost, which delivers humus to the soil. The application of such compost is key to the system. In addition, on-farm biodiversity is rated with the so-called Biocyclic Operation Index and must reach a level of six out of ten points [48].

Eisenbach [49] ran first field experiments with sweet potatoes and tomatoes comparing biocyclic-vegan and organic agriculture. She reported considerable additional yields if compost is applied to the crops.

3.2. Conventional Vegan Nutrient Management

It is probably unwise to rely fully on an extension of organic farming when considering the option of a (regional or national) full conversion to a post-lethal system. A meta-study by de Ponti et al. [50] showed that organic crops yield, on average, 20% less than conventional ones, and that the gap is rather increasing over time. At the same time, costs for organic production are usually higher than for conventional crop production [51]. If most farmers in Western countries rely on mineral fertilizers and synthetic pesticides, it is crucial to define a post-lethal agrarian system in which these materials are still accessible.

If animals are not part of the farming system anymore and manure is, accordingly, not available, there are basically three different ways to cope with this cessation:

- Working solely with mineral fertilizer may be a viable way. This approach does not necessarily mean that more mineral fertilizer would be applied. To the contrary, field experiments by Görlitz and Asmus [52] showed that the yield-maximizing effect of mineral fertilizer application is higher if 50 kg/ha organic fertilizer is also added. However, it can be expected that yields without organic fertilizer would decline by around 10%. The effect of skipping organic fertilization on soil composition would be more significant. C/N ratios in soils without organic fertilizer are low [53], NH3-N is low [54] and bacteria concentration rather high [55], while microbial biomass is low [56]. Long-term experiments of using only mineral fertilizer show that the productive capacity of soils remains more or less intact, even if the organic content declines [57,58].
- It is certainly advantageous, in terms of both yield and organic substance in the soil, if the manure of animal origin can be substituted with vegetal matter. The biocyclic-vegan standard is just a case in point in this practice, but vegetal fertilizer can be combined with mineral substance, and it also can be used in different stages. In a paper on vegan greenhouse production, for example, Schmutz and Foresi [59] mentioned "plant-based composts, mulches and other biomass". Wastewater from the processing of crops, such as cassava wastewater [60], would also fall into this category. Although a lot of positive experience with a broad variety of vegetal fertilizers is available [61–63], a vegan system on a broader scale would face the challenge of organizing enough vegetal substance for organic fertilization. It is yet unclear, for example, whether more investment in catch crops would be necessary compared with today's situation to maintain soil fertility.
- Petterson and Wikström [64] reported from a trial that one person produces human fertilizer amounting to a value of EUR 50 per year. In an agricultural system in which animal manure becomes unavailable, it is likely that this value rather rises than falls. However, with the current sewage systems, the use of human fertilizer poses serious issues of hygiene and toxicity [65]. Mahon et al. [66] and Li et al. [67] recently reported problems of microplastics in sewage sludge, whereas problems of toxic metal residues [68] or phenolic compounds [69] have been known for a longer time. Several countries reacted to these and similar problems by banning the use of sewage sludge in agriculture, and others imposed severe restrictions. The incentive to invest in more sustainable systems of utilizing sewage sludge may become a worthwhile issue in a vegan society.

4. The Fate of Grassland

Animals do not only produce manure, some of them currently also provide the most economical way of utilizing grassland. Cattle, sheep and goats are the most important species which either graze on pastures or are fed with grass harvested by machines. This leads to the question what would happen to the grassland in a post-lethal agricultural system. The use of the land could certainly be transformed, whereas in other cases animals might still play a role.

4.1. Substitution

The Umweltbundesamt [70] reported a significant reduction of grassland in Germany between 1991 and 2003, which had been caused by economic forces and only halted by a change in the Common

Agricultural Policy that, due to the negative environmental impact of grassland ploughing [71], provided incentives to keep the grassland. It is difficult to obtain numbers on the share of today's grassland that may be arable land in the future, and these numbers would differ strongly between regions; but it is safe to assume that in productive regions, the conversion to arable land is the most likely destiny of grassland not used for grass production anymore.

In remote and less fertile areas, it is much more likely that shrubland and eventually forests will replace unused grassland. Such transitions are well known, albeit without any reference to veganism [72]. The normative connotation of such developments varies strongly depending on socioeconomic conditions. The afforestation of grassland in Ecuador by economically attractive pine plantations has been described as a means of economic development [73], whereas the natural afforestation after the abandonment of active grassland management on some slopes in the Austrian Alps has been described as landscape degradation [74]. In any case, forest–grassland transects are rich in biodiversity [75,76] so that abandoning grassland will have detrimental effects on species richness.

4.2. Post-Lethal Grassland Management

Grassland, at least in some locations, provides positive externalities [77]. This is true because of its effect on biodiversity [78], but also as part of an attractive landscape [79–81]. It is therefore worthwhile to consider how the killing of animals and the management of grassland can be decoupled.

The simplest option in this case is certainly the mechanical preservation of grassland. The Bavarian Office for the Environment [82] collected calculations of average costs for preserving grassland without animals. If the cut grass is left on the plot, costs vary (dependent on natural conditions) between EUR 30 and 150 per hectare, whereas costs for mowing and removing the grass average EUR 180 per hectare. The demand for compost (see Section 3) will often justify the cutting and removal of the grass. However, society's willingness to pay does not have to be excessively high to justify mechanical grassland management.

The Bavarian Office for the Environment [82] also calculated costs of grassland preservation through animals. Again, the cost level is strongly dependent on the natural conditions. If animals can survive the winter on the land, the resulting costs per hectare are rather lower than the costs for mechanical grassland management.

This observation raises an important issue: vegan agriculture is not necessarily agriculture without animals. Meyer-Glitza [83,84] focused on systems that keep, but do not kill animals. Today, most of the few existing cases are benevolent non-profit farms, which keep animals not needed on productive farms anymore in order to rescue them from being slaughtered. In a major vegan system, it should be accepted that ruminants are kept as a low-priced means for preserving grassland.

On a few of the farms analyzed by Meyer-Glitza [84], cows are milked, but are not killed after their productive period. This indicates that a post-lethal agricultural system is not necessarily a vegan system but could be entirely vegetarian. Although the ethics of milking is a controversial issue [85–87], it is important to note that today's link between milk and egg production and the killing of animals is not a necessary link. A system in which both male and female animals could live to their natural death or where (in the case of cows) sexed sperm is used to avoid the birth of male animals [88] would radically change livestock husbandry. Due to the decrease in fertility over an animal's life course and the "unproductive" lifetime of animals, it is plausible to assume that the price of milk and eggs would rise by a major factor.

5. Beekeeping

In today's agricultural system, bees play a crucial role that can hardly be substituted. This raises the question if the idea of a post-lethal system can be extended to bee-keeping. Bees are not slaughtered in conventional agriculture, so there is disagreement if honey can be part of a vegan diet [89]. Morris [90] summarized both utilitarian and deontological arguments against taking honey from bees. If society subscribed to his arguments, would many fields not be pollinated anymore because most bees rely on human support in surviving winter periods?

Not many vegans argue against the use of bees in pollination. Even today, many beehives are kept for just this service, with honey becoming a secondary outcome of the bees' activities. Sumner and Boriss [91], Desjardins and de Oliveira [92] and many other economists described this emergence of a new market due to shifting scarcities. Because farmers, particularly in the fruit sector, are willing to pay for pollination of their crops, there is no reason to assume that this service would vanish in a post-lethal system.

6. Discussion: Emerging Post-Lethal Systems

The good news: if geographical entities decided to switch to post-lethal agricultural systems, this would be an entirely possible option. There might be eco-villages [93] or biosphere reserves [94] before entire nations may decide to follow this path.

In fact, while any farmer today can and must choose between different production systems anyway, there are also several possible, differing post-lethal systems imaginable. Furthermore, many rural sociologists [95,96] showed how both external socioeconomic and internal motivational factors drive this choice, and these factors will certainly influence farmers' choices in post-lethal agriculture. The following general types of systems can be distinguished.

- Vegan-organic agriculture will be able to overcome the challenge of substituting organic manure. The proponents of biocyclic-vegan agriculture have shown compost as an option. Other options involve less composted vegetal materials like leaves or straw, but possibly also sewage sludge.
- Vegan-conventional agriculture would continue to cover the major part of nutrient losses from harvests through mineral fertilizer. However, to keep the organic content up in arable soils, the same substitutes as in vegan-organic agriculture would be applied.
- Post-lethal vegetarian agriculture, being organic or not, would continue to use animals, especially for grassland management, but would not kill them. Even chicken and bees might be part of such a system to secure the future supply of eggs and honey to the table, even though production costs would exceed today's costs by several factors.

7. Open Questions

Often, academic papers conclude with a reference to one or two open questions that still need research. In the case of post-lethal agricultural systems, the number of open, unresolved questions is much larger than that.

Although many systems can be described as technically possible, their physical productivity is largely unknown. The first few field trials of biocyclic-vegan farming may have brought optimistic results. However, these first findings only underline the necessity of experimenting with many varieties of arable systems without animal manure. This necessity includes long-term trials with an emphasis on organic content in arable soils.

It is likely that organic substances from human waste systems will gain importance in post-lethal agriculture. It may therefore be worthwhile to invest in hygienic standards, substantially reducing the influx of toxic substances, which would deteriorate arable production. Thus, post-lethal agriculture may induce innovation in waste management.

Post-lethal vegetarian agriculture introduces a long list of new challenges in animal management. How could long-time fertility of chicken or cows be preserved? What are the dynamics of chicken groups with an equal balance of male and female animals? What production costs result from systems in which all animals are fed while only some are productive?

This last question leads to the entire issue of agricultural economics. For example, Swiss farmers today make more than three times as much revenue from selling animal products than from selling vegetal products. The structural change that post-lethal agriculture would induce must be both understood and wisely managed.

As it is likely that part of our global society is going to demand post-lethal agricultural production rather sooner than later, it would be wise to now develop the research agenda connected with such a switch.

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