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Cover Page Footnote

It should be acknowledged that in addition to being a doctoral student and veganic researcher, Alisha co-owns and manages a commercial veganic farm in Grand Isle, Vermont. The research described in this article was funded through the generosity of individual donors via the online crowdfunding platform, "Experiment". Research updates are available at www.experiment.com/veganic. We would like to thank the veganic farmers who participated in this study, without whom this project would not be possible. Gratitude is also extended to Alisha's graduate studies committee for their support and guidance: Ernesto Méndez, Jason Parker, Daniel Tobin, Terence Bradshaw, and the late Bob Parsons.

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Veganic Agriculture in the United States: Opportunities for Research, Outreach, and Education

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Abstract. A growing number of farmers are excluding animal inputs from crop production, an approach commonly referred to as veganic or stockfree organic agriculture. This research-based article discusses the soil health and fertility strategies reported by a sample of U.S. veganic farmers. These approaches may be relevant beyond the veganic community to farmers seeking innovative methods for produce safety and nutrient cycling. Agricultural outreach professionals (AOPs), including Extension personnel, play a critical role in supporting veganic practices by serving as cross-pollinators between farmers and research institutions. Thus, the article endeavors to expand AOP familiarity with veganic practices and benefits.

INTRODUCTION

There is increasing interest in alternative agriculture as a means to address theoretical and practical farming issues ranging from produce safety to climate-change adaptation. One farming approach that is gaining recognition in the United States is veganic agriculture, which is also referred to as "vegan organic" or "stockfree organic" agriculture (Hall & Tolhurst, 2006; Schmutz & Foresi, 2017). Veganic agriculture shares many of the same principles of organic farming, such as avoidance of synthetic fertilizers, synthetic pesticides, and genetically modified organisms (U.S. Department of Agriculture [USDA], 2016); it additionally eschews the use of animal-derived inputs that are commonplace in U.S. organic agriculture, including manure, blood/feather/fish meals, and bone char. There are also many other essential considerations within veganic agriculture. For example, the Veganic Agriculture Network of North America (VAN; 2014) has promoted an iteration of veganic farming that "encompasses a respect for animals, the environment, and human health" through eliminating the use of animal-derived products, encouraging biodiversity, maximizing the amount of fertility produced on-farm by feeding the soil organic plant-based materials, and minimizing the use of fossil fuels (para. 1). U.S. farmers may access two forms of veganic certification. The Stockfree Organic Services program in the United Kingdom offers a Stockfree certification to non-U.K. growers (VAN, 2011; Stockfree Organic Services, 2020). Additionally, the International Foundation of Organic Agriculture Movements oversees the Biocyclic Vegan Standard, which guides implementation of a veganic approach globally (Biocyclic Vegan, 2017).

We put forth the term "agricultural outreach professionals" (AOPs) to encompass individuals engaged in agricultural information development and dissemination. AOPs may work on behalf of a range of entities, such as cooperative extensions, land-grant universities, nonprofit organizations, and/or private businesses. Extension educators serve a unique role as liaisons between researchers and communities of practice; Colasanti et al. (2009) have advocated for a reinvigoration of outreach through processes that are participatory, equitable, and democratic. With a relatively small agronomic literature base, veganic agriculture presents the potential for the horizontal co-creation of new knowledge.

In the following sections, we provide an overview of relevant veganic literature and a discussion of the findings from our interviews with veganic farmers throughout the United States, with a focus on plant-based fertility strategies. We also review some benefits of veganic agriculture, including enhanced food safety and improved nutrient cycling. Lastly, we highlight the potential role of AOPs in the future of veganic agriculture, with an emphasis on Extension personnel serving as liaisons between farmers, researchers, and/or community members.

LITERATURE REVIEW

The body of research on veganic practices and principles is limited and often does not explicitly use the term "veganic." For instance, the 30-year "Farming Systems Trial" conducted by researchers at the Rodale Institute in Pennsylvania explored three production systems with consideration of till and no-till scenarios: synthetic conventional, organic manure, and organic legume, with the latter aligning with veganic fertility practices (Rodale Institute, n.d.). Organic strategies demonstrated advantages over synthetic conventional techniques, including comparable or higher yields, increased biomass above and below ground, enhanced soil organic matter and nitrogen, and improved conservation of resources with a reduced need for inputs, such as pesticides (Lotter, 2003; Pimentel et al., 2005). Various stockless organic trials in the United Kingdom that excluded farmed animal inputs have noted the viability of the approach based on macronutrient levels, yields compared to organic production, and resilience to insect and disease pressure (Cormack et al., 2003; Welsh et al., 2002). In Greece, a biocyclic humus soil composed entirely of plant materials was found to quantifiably exceed the soil benefits of inorganic counterparts (Eisenbach et al., 2018). Existing field trials have been limited in regionality and crop type; further research is required to better represent potential broader applications.

Additionally, grower-authored resources detailing veganic growing strategies exist. For example, in Europe, Hall and Tolhurst (2006) have provided a foundational overview of animal-free organic gardening and farming, Burnett (2014) has described a veganic approach to permaculture, and Appleby (2018) has discussed veganic gardening. In the United States, Bonsall (2015) has explored veganic gardening through the perspective of self-sufficiency. However, a comprehensive overview of the prevailing commercial veganic practices and principles is lacking, especially in the United States.

METHODS

To address the existing information gap on veganic practices in the United States, we led a 2018 research study of commercial U.S. veganic farms; there was no minimum gross income required to constitute as commercial. Farms included in this study were all soil-based and produced diversified crops, thus excluding a limited number of veganic hydroponic and/or nondiversified farms.

At the time of recruitment, approximately 50 commercial veganic produce farms were in operation in the United States (Seymour, 2018). Farmers were recruited using snowball sampling, resulting in 19 participant farms from 11 states (Table 1). Both authors' Institutional Review Boards approved of the study, and participant names have been changed for anonymity.

Mixed-methods data collection occurred via an online quantitative pre-interview survey and semistructured interviews, which were mostly conducted in person. Transcripts were open-coded, and then thematic analysis with cross-checking for reliability occurred. The plant-based fertility strategies discussed henceforth originated from the interviews. The survey results, including participant demographics and farm business attributes, are not reported here but are encompassed within Seymour and Utter (2021).

Table 1. Veganic Participant Farms from Each State

State	# of participant farms
California	4
Florida	1
Indiana	1
Maine	2
Massachusetts	1
Michigan	2
New York	1
North Carolina	1
Oregon	4
Washington	1
West Virginia	1
Total	19

RESULTS AND DISCUSSION

APPROACHES TO VEGANIC SOIL FERTILITY

Interviews with veganic farmers confirmed a wide variety of strategies for navigating crop fertility and soil health, ranging from input substitution via bagged amendments to intensive on-farm nutrient cycling. The benefits and challenges of each strategy varied across different regional, spatial, and temporal scales. The subsequent recommended techniques share the commonality of being vetted by veganic farmers and being identified as practical and cost-effective.

Plant Meals (Macronutrients) and Mineral Amendments (Micronutrients)

In alignment with the agronomic approach in which the balance of nitrogen, phosphorus, and potassium (NPK) is a guiding component to crop management, some veganic farmers reported using bagged fertilizer, such as plant meals (e.g., peanut, cottonseed, soybean, alfalfa, seaweed). Sources of readily available nitrogen and phosphorus were repeatedly identified as two of the leading challenges for veganic annual crop producers, especially for heavy feeding crops during the spring and fall. Generally, farmers were purchasing macronutrient products for short-term intervention to supplement long-term soil-building strategies.

Several farmers also cited the addition of mineral amendments as an important piece of their soil-management approach. Minerals, such as boron, calcium, and magnesium, were reportedly sourced off-farm from agricultural suppliers or direct from mines. “Howie” reported using plant meals and mineral amendments for specific crops that he knew would “need the extra boost beyond just enriching the soil by compost and cover crops.” “Dale” also supplemented off-farm micronutrients with on-farm biochar production. In each of these examples, farmers attributed their decision-making process regarding amendments to their personal insights shaped through observation/experience and soil test-result recommendations.

Compost and Minimally Processed Decomposing Plant Materials (Nonplant Meals)

A majority of interviewees highlighted the value of incorporating compost into the soil. Several also discussed using alternative plant mulches (e.g., leaves, wood chips, straw) to regenerate the soil. In both cases, whether the compost and/or plant materials were produced on-site or off-site varied. One advantage to outsourcing fertilizers and soil amendments is that it can help address the inherent deficits of commercial farming, in which plant materials are continuously being removed off-farm as marketable crops.

Many farmers also noted a shortage of veganic compost because it is generally not available commercially and there are on-farm limitations to production, such as labor requirements and availability of plant materials. In some areas, farmers reported leveraging agricultural by-products. For instance, in California, “Kevin” reported using grape pomace (skins, leaves, and stems leftover from processing) and encouraged other growers to do the same with materials available in their region.

Cover Crops, Green Manures, and Living Mulches

Although cover crops may technically be removed from the field as a commercial crop (thus, distinguishing them from green manures), farmer participants referenced cover crops and green manures as crops grown with the intention of incorporating at least a portion of the plant back into the soil to enhance soil health. “Mitch” described cover crops/green manures as being the “key to this whole process,” especially the rotational component of his crop planning, including land fallowing. In contrast to taking land out of production, “Ray” discussed the technique of intercropping with legumes that provided sustenance and/or a marketable crop while fixing nitrogen. “John” stressed the importance of cover cropping and explained:

> When I nail that [cover cropping] and it’s been managed properly . . . it just feels like that field is going to do the best by far. . . . I think that’s the number-one preaching that I would say if you’re going to be veganic . . . like really get that [cover cropping] down.

“Laura” described a management system where she grows her own fertilizer through the incorporation of living mulches between crop rows for “soil building and habitat building” and “cycling nutrients with maintaining a blooming seeding cover year-round for natural enemies.” Methods for catalyzing the return of plant materials into the soil varied across farms, ranging from solarization by using tarps to hand tools (e.g., scythes) to tractor implements. Even veganic farmers who did not implement cover crops/green manures/living mulches acknowledged the value in doing so. For example, although “Pam” cited challenges in getting a cover crop established before the end of her growing season, she still leaves plant debris in the field to provide soil coverage in the winter.

BENEFITS OF VEGANIC, PLANT-BASED FERTILITY APPROACHES

The aforementioned fertility practices are applicable to a range of farming approaches. This section highlights the benefits that may be of most interest to the larger agricultural community, specifically food safety and improved nutrient cycling.

Food Safety for Produce Growers

A variety of potential challenges are associated with animal-derived inputs; thus, excluding them from production yields specific benefits. For example, the application of farmed animal manures presents the risk of the introduction of pathogens that can cause disease in humans, such as *E. coli 0157*, *Listeria*, and *Salmonella* (Spencer & Guan, 2004; Venglovsky et al., 2009). Compared to conventional or integrated production systems, organic systems have a higher reliance on animal-waste by-products and compost for soil health and fertility (Alsanius et al., 2019). In many instances, these by-products are sourced from intensive conventional systems, which often have characteristics, such as feed type, associated with increased pathogen survival and potential spread (Franz et al., 2005). Alsanius et al. (2019) have posited that livestock-free inputs, such as those used in veganic agriculture, are a means to reduce pathogenicity related to soil health and fertility. Studies such as that of Kang et al. (2013) have shown the potential for plants to absorb antibiotics from manure applications. Concerns regarding antibiotics and hormones entering crops were cited as an additional motivation for veganic farmers, such as Pam and "Steve," to avoid using manure.

Relatedly, stringencies and expectations surrounding food safety have increased for U.S. produce growers. The first significant update to U.S. food regulations since 1938 occurred in 2011 with the establishment of the Food Safety Modernization Act (FSMA). Encompassed within FSMA are the "Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption" (the "Produce Safety Rule"), which emphasize limiting risks/hazards associated with animal-derived pathogens. FSMA defines biological soil amendments of animal origin as raw farmed animal manure and meals made from animal by-products (Food and Drug Administration [FDA], 2020). Although the exact standards are still being determined by the FDA, general guidance within FSMA is similar to the National Organic Program standards, which require a 90- to 120-day waiting period between the application of manure and harvest (USDA, 2020). This presents challenges for produce farmers, especially those in areas with short growing seasons that have a limited time frame in which to incorporate soil amendments and produce crops.

The use of veganic fertility techniques may also ease the recordkeeping and compliance burden for farmers. For example, "Martha" explained:

> We are GAP-certified [Good Agricultural Practice], and because we don't use any animal by-products, like fertilizer, animal manures, and all that, we can skip a whole chapter in our food safety certification. . . . [T]hat's a big plus, and you don't have to do extra paperwork.

Martha went on to express that using plant-based fertility has given her increased confidence in the safety of her produce. Simplifying logistics and improving peace of mind about their products were additional advantages to the general practicality of veganic fertility within their intensive growing system. There is also indication that nonveganic produce farmers are transitioning from animal manures to green manures due to produce safety (Tong et al., 2017).

Nutrient Cycling

In addition to food-safety challenges, nutrient cycling with animal by-products poses other limitations. For example, the nutrients from farmed animal manure may not be readily available to crops across different spatial and temporal parameters, which can result in nutrient leaching (Edmeades, 2003; Zhang et al., 2006).

Although the use of cover crops/green manures is sometimes framed as a technique to absorb nutrients from animal-based amendments, such as phosphorus from manure, a simpler strategy may be to exclusively use plant-based fertility practices. Cover crops/green manures are well recognized for their short-term benefits, including reduced erosion and runoff, and long-term contributions, such as increased organic matter (Fageria et al., 2005; Larkin, 2019; Sarrantonio & Gallandt, 2008). As Kevin described:

> I find I am overall doing less work because my green waste, and any additions to it that I may need, can be produced on-site. I haven't seen any negative effects, only benefits, when it comes to building up the soil and seeing that the levels of the soil naturally increase versus where I was adding manure, blood meal, bone meal, and those sorts of things. . . . [They] would be washed away a lot more easily and didn't build up the soil like my techniques that have developed recently with veganics.

Additionally, expanding state- and federal-level policy frameworks regulating nonpoint agricultural pollution, including manure, may catalyze the increased use of plant-based fertility. Veganic practices, such as cover cropping/green manures, are important tools to help growers navigate nutrient cycling and retention.

RECOMMENDATIONS FOR FUTURE RESEARCH AND SUPPORT

Through their work with farmers, AOPs have the capacity to influence the recognition, adaptation, and evolution of alternative agriculture. Specifically, Cooperative Extension's research-forward approach well positions its educators to explore the applications of veganic agriculture.

Although the body of knowledge on green manures and cover crops is relatively robust, and the literature base on plant-based mulches is expanding, other areas still need further examination. For example, on-farm nutrient production and cycling using biochar and intensive plant-based composts require further research. Additionally, there may be a growing need for legal and/or functional guidance related to the evolving sociopolitical framework, such as parameters for collecting community food waste and accessing government incentive programs for using sustainable/regenerative practices, especially for relatively small-scale, diversified farms.

These gaps present potential for AOPs to work with veganic farmers to co-create new knowledge. For instance, Mitch described an experience in which he experimented with applying calcium at higher rates than recommended by his local Extension personnel. When they saw the results that Mitch was able to produce, the Extension agents were receptive and have since pursued a collaborative relationship with him. Similarly, Dale used biochar and mineral amendments to rehabilitate soils that were previously deemed unworthy of crop production by local Extension agents, and he now continues to exchange information with AOPs. Moving forward, there is significant potential for further research and market development related to plant materials to enhance crop production and soil health.

Improved knowledge on veganic fertility strategies would be especially valuable for veganic constituents, many of whom are relatively isolated from one another and reported seeking information from local Extension personnel. For example, "Colleen" believed that she could turn to her local Extension agent with questions, explaining, "[L]ast year, I had a very specific problem, and I reached out to them, and they were very helpful in solving it. . . . [T]hey're actually a great resource." However, Colleen identified fertilizers as a "stopping point" because guidance typically involved animal-based inputs, which required her to do her own research to find other options.

In addition to engaging with the veganic community, AOPs are in a position to discuss plant-based fertility techniques with other farmers concerned with issues of food safety and nutrient cycling. Organic farmers who incorporate only minute amounts of animal-based fertilizers may be especially primed for transition possibilities. Additionally, it is important for AOPs to note that they may encounter farmers who incidentally grow veganically but are unfamiliar with the term; AOPs may then be instrumental in introducing these farmers to a broader veganic framework.

As veganic farming continues to gain momentum, and as stringency increases in such areas as produce safety and agricultural pollution, it is critical that AOPs possess a foundational understanding of veganic practices and principles. These have applications across a range of farming approaches and may present opportunities for novel research and collaboration.

CONCLUSION

U.S. veganic farmers reported a wide spectrum of approaches to soil health and fertility, ranging from input substitution-based systems dependent on off-farm plant amendments to intensive on-farm cycling of plant materials for long-term soil improvement. The practices and principles of veganic farming are relevant to veganic growers and to the larger agricultural community navigating challenges related to crop production and land stewardship, such as climate change and regulatory frameworks. By recognizing the concepts and characteristics of veganic agriculture, AOPs will be better positioned to engage with the growing veganic farming community while offering all farmers a greater diversity of resources and information on alternative approaches.

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