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Using TAPE to assess agroecology on women-led farms in the U.S.: Support for environmental and social practices

Lianna Gomori-Ruben [a] * and Chantal D. Reid [b]
Duke University

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Abstract

Agriculture models predicated upon producing monocultures for export have proven unsustainable. In response, the Food and Agriculture Organization of the United Nations (FAO) has called for nations to produce food agroecologically in alignment with natural ecosystems. The FAO identified women as critical yet underrepresented leaders in agroecology projects worldwide. Prior research about agroecology and women farmers has primarily been situated in low-income nations. This study examines women farming in the United States as a high-income nation to analyze if their practices align with agroecology using the FAO's 10 Elements of Agroecology and the FAO's Tool for Agroecology Performance Evaluation (TAPE). A mixed-methods case study design was used to collect web-based survey and interview data from 87 participants. We found that the participating women farmers tended to lead agroecological farming projects that provide direct nutritional, environmental, educational, and social services to their communities in alignment with elements of agroecology. Ninety percent of participants operated farms at 100 acres (405 hectares) or less that mostly used direct sales models (farmers markets, community supported agriculture operations [CSAs], farm stands, and online sales), and half of participants offered opportunities for intergenerational engagement. These practices align with the FAO's elements of Diversity, Co-creation and

[a] * *Corresponding author:* Lianna Gomori-Ruben, Master's student, Duke University Nicholas School of the Environment; Durham, NC, USA.

Lianna is now an independent consultant. She can be contacted at +1-917-225-8340; lianna.g.ruben@gmail.com

[b] Dr. Chantal D. Reid, Professor Emeritus, Duke University Nicholas School of the Environment; 9 Circuit Drive; Durham, NC 27710 USA; chantal@duke.edu

Author Note

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Disclosures

The authors declare that they have no conflicts of interest.

Sharing of Knowledge, Resilience, Human and Social Values, Culture and Food Traditions, and a Circular and Solidarity Economy. Environmentally, participants emphasized using practices for crop diversity, building soil health, and integrating animals in alignment with the FAO elements of Diversity, Synergies, Recycling, and Resilience. Farm size and region were significant in the prevalence of agroecological practices. Farms of 50–100 acres (202–405 hectares) were most likely to integrate animals, and farms in the Southeast were most likely to identify with conventional agricultural practices. Our data show that women-led farms in the U.S. align with sustainable agricultural practices as articulated by the FAO and, as in low-income nations, women play a valuable role in advancing a national agroecological transition.

Keywords
agroecology, community building, farm size, farm management, FAO, agroecology elements, women farmers, mixed-methods case study, resilience, sustainable agriculture

Introduction

The food system is dominated by conventional rather than sustainable practices. Building the food system upon conventional industrial agriculture that puts profitability and productivity at the center has proven to be a significant driver of the current climate crisis. The practices used are environmentally unsustainable, fueling deforestation, soil erosion, and water consumption, while failing to adequately nourish the global population (Altieri et al., 2012; FAO, 2018; Gliessman, 2015; Montgomery, 2007; Willett et al., 2019). Alternatively, agroecology is an approach to produce food equitably and environmentally sustainably by centering environmental health, economic viability, social equity, and the political power to decide the food that is produced and consumed within one's community (Altieri, 1988; Anderson et al., 2020; FAO, 2022b; IPES-Food, 2018; Gliessman, 2015; González De Molina & Lopez-Garcia, 2021; Holt-Gimenez & Altieri, 2013). To foster transitions toward equity and sustainability, the United Nations Food and Agriculture Organization (FAO) works to apply the United Nations' Sustainable Development Goals to food systems through agroecology.[1]

Agroecology today is defined as a holistic applied science that situates agriculture within ecological and socioeconomic systems and a context of justice and human rights to develop sustainable food systems (Altieri, 1988; FAO, 2022b; Gliessman, 2015; Holt-Gimenez & Altieri, 2013). The term has evolved since its initial usage in scientific literature to describe the application of ecological principles to agriculture for commercial crop production (Bensin, 1928, 1930). During the environmental movements of the 1960s and 1970s, the concept of agroecology expanded to incorporate opposition to industrial agriculture (FAO, 2019; Lutzenberger, 1976; Wezel et al., 2009). In the 1980s, agroecology was defined as an applied science focused on protecting natural resources and developing sustainable agroecosystems (Altieri, 1989; Gliessman, 1997; Wezel et al., 2009). It has since expanded to include eliminating exploitation and measuring success through food sovereignty, food security, and ecological and human health (Anderson et al., 2020; Zaremba et al., 2021).

Worldwide, women have been identified as leaders of agroecology projects, so understanding their roles in food systems is critical (FAO, 2022a). Women tend to lead decision-making around food acquisition, preparation, and consumption in their households (Anderson et al., 2020). Despite performing agricultural labor at the same rate as men, women are underrepresented in—and often marginalized from—land ownership and political power. An agroecology model that achieves gender equality would apply feminist economics to conceptualize value in care provision and reproductive work along with productivity and profit (Di Masso et al., 2022). Care provision and reproductive work, in this sense, encompass the long-term life-cycle maintenance of living ecosystems (Di Masso et al., 2022). The FAO's agroecology initiatives seek to empower women in food systems by expanding their access to economic opportunity and their capacity to collectively organize (FAO, 2018). Previous research about agroecology and women has

[1] Agroecology works toward achieving Sustainable Development Goals 1–6, 8, and 10–17 (FAO, 2022c).

been concentrated in low-income nations by emphasizing the economic benefits that would be realized through increasing women's empowerment (Anderson et al., 2020; Bezner Kerr et al., 2019; Paz Hidalgo, 2020; Trevilla Espinal et al., 2021). High-income nations are often sites of gender inequality as well with unrealized economic potential. A recent study of gender equality in 149 nations ranked the U.S. 51st (World Economic Forum, 2021). The purpose of this case study is to include the U.S. in the FAO's work as a high-income nation that is a site of gender inequality and to evaluate whether and how the U.S. may also stand to benefit economically, environmentally, and nutritionally from the equal empowerment of women in farming. We examined women farming in the U.S. by assessing their agricultural practices for alignment with agroecology. We used the FAO agroecology assessment tools to develop internet surveys and phone interviews.

Women Farming in the United States

The U. S. Department of Agriculture (USDA) has collected national farm data every five years since 1840 through the Census of Agriculture, but long-term data on farmers by sex is lacking. The term "farmer" was initially defined as the sole or primary operator of a farm, and only one farmer could be listed per farm. Men were typically listed as the farmers on record despite often farming alongside women in farm family structures, which is illustrative of a history of heteropatriarchy both within the U.S. and in farming (Hoffelmeyer et al., 2023). The first census to classify farmers by sex was in 1978, and women represented 5.2% of farmers on record (Kalbacher, 1985). By 1997, the number of women farmers reached 9%, a near doubling (Hoppe & Korb, 2013). Since then, further changes in the census classifications and definitions have allowed for better documentation of women's leadership on farms. In 2002, the census changed the farmer category to allow up to three farm operators and one principal farm operator, the distinction being that farm operators were in charge of daily decision-making and the principal farm operator was additionally charged with census data collection (Pilgeram et al., 2020). In 2017, the census changed to allow the indication of up to four farm operators, of whom zero to four could be indicated as principal farm operators as well (Pilgeram et al., 2020). As of 2017, 56% of farms had at least one female farm operator, and 36% of all principal farm operators were women (USDA NASS, 2019). While the growth in the number of registered female farmers is largely related to changes in census methodology, the number of women farmers on record as decision-makers is higher than ever before (White & King, 2019). Calls to refine the census methodology continue today to capture the spectrum of farmers' genders and sexualities. A study by Dentzman et al. (2021) determined that queer farmers make different management decisions than their non-queer counterparts. While this study is focused on the practices of women farmers, sexuality and intersectionality are important factors that affect farm management and complicate conclusions about women as a group.

Census data indicate that female farmers tend to make different management decisions than male farmers. In 1978, women farmed on smaller plots of land, averaging 235 acres (95 hectares) compared to men's 423 acres (171 hectares), and they generated less income, with an average of US$16,000 compared to men's US$26,000. Women also owned their farms at higher rates (79%) than men (58%), carried debt at lower rates (37%) than men (58%), and averaged less debt (US$45,000) than men (US$84,000; Kalbacher, 1985). The 2002 and 2007 censuses showed that women were more likely to operate small, diversified farms and to certify as organic than men, and men were more likely than women to produce commodity crops such as corn, grain, soybeans, oilseed, hogs, and beef cattle (Barbercheck et al., 2014; USDA NASS, 2002; 2007). As of 2017, the average female-operated farm generated US$28,259 compared to the national average of US$43,053 (USDA NASS, 2017).

Women-led farms show trends in location choices, sales models, and service offerings. In an analysis of census data, Schmidt et al. (2021) found that women tended to farm on smaller farms in urbanized areas with higher population densities rather than larger farms in remote rural areas. Women were more likely than men to farm in areas with higher income levels, greater childcare access,

and more equitable income distribution (Inwood & Stengel, 2020; Schmidt et al., 2021). In comparison to their male counterparts, women farmers were more likely to use direct marketing models to sell their products (Ahearn et al., 2018; Fremstad & Paul, 2020) and to farm using organic rather than conventional methods (Fremstad & Paul, 2020). They tend to utilize shorter supply chains and incorporate agritourism and other social programs (Schmidt et al., 2021).

Women approach farming through different social values than men, which affect their management decisions. For example, an Iowa study explored why the majority of community supported agriculture (CSA) arrangements were operated by women farmers and found that the participating women chose the CSA model because it incorporated their values of caring for the community and the environment better than conventional agriculture models (Wells & Gradwell, 2001). A study of women farmers in Pennsylvania found that the participants defined success in terms of profit, productivity, and service provision to the community (Trauger, 2004), and another study found that women identify social needs in the community that they then monetize (Trauger et al., 2009). Lastly, women farmers are more likely to engage in social networks for information sharing and to implement conservation practices if they understand how the practices align with their long-term goals (Bregendahl & Hoffman, 2010).

Comparisons of farm management decisions made by women against those of men suggest that the farming landscape may shift as women's representation in farm leadership increases. However, research on women's farming practices is limited globally, particularly in high-income countries including the U.S. (Ball, 2020; Schmidt et al., 2021). Given the few studies reporting on women farmers in the U.S. coupled with evidence of agroecology practiced by women in Latin America and Africa, this study seeks to address the following questions: what are the practices and approaches of women farmers throughout the U.S., and how do those practices align with the FAO's frameworks of agroecology? By assessing the landscape of American women-led agriculture, this study seeks to illustrate how sustainable food systems could be developed broadly in the U.S. as part of a global agroecological transition in relation to the UN Sustainable Development Goals and what role women farmers can play in that transition.

Materials and Methods

Study Design and Materials

This study utilized a mixed-methods case-study design to combine data from a web-based survey and semi-structured interviews to provide complementary data for interpretation and analysis (Creswell & Plano Clarke, 2018). Case-study research focuses on the complexity of a single case as a bounded system to identify a phenomenon of interest (Stake, 1995). This case study was bounded to focus on women farming in the U.S. within a period of four months from October 2020 to January 2021. Quantitative data from the web-based survey were used to identify trends across women nationwide, while qualitative data from the semi-structured interviews were used to gain an in-depth understanding of the experience of a small subset of women in agriculture leadership roles. A triangulation design and a convergence model were used to compare and contrast the quantitative and qualitative data concurrently to develop themes for interpretation (Creswell et al., 2003; Creswell & Plano Clark, 2018). Due to the case-study approach and the sampling methods, this research is exploratory in nature, as the women selected to participate are not a large representative sample of all women farmers in the U.S.

Questions for data collection were developed using the Tool for Agroecology Performance Evaluation (TAPE; FAO, 2019) based on the FAO's 10 Elements of Agroecology (FAO, 2018). The survey items and interview questions are adapted from the TAPE's Step 1: Characterization of Agroecological Transitions (CAET), which addresses the Elements of Agroecology (Diversity, Synergies, Efficiency, Recycling, Resilience, Culture and Food Traditions, Co-creation and Sharing of Knowledge, Circular and Solidarity Economy, Human and Social Values, and Responsible Governance) and Step 2: Core Criteria of Performance (Mottet at al., 2020). The CAET provides an objective tool to assess farmers' progress toward agroe-

cology. The survey and the interview guide were structured according to the TAPE's five key dimensions of Economy, Environment, Health and Nutrition, Society and Culture, and Governance. The survey was created and distributed through Qualtrics survey design software, with 82 questions that included multiple choice, Likert-scale, and open-ended freeform. The interview guide consisted of 17 open-ended questions to capture data parallel to the web survey.

The evaluation rubrics of the CAET were developed mostly in the context of low-income nations and include the role of women. Because our survey was centered on women in the U.S., we adapted some items and indicators. Table 1 shows the TAPE's original dimensions and core criteria of performance and the modified indicators that we used in this study. We chose to exclude diet and nutrition indicators from the Culture and Food Traditions element. The TAPE's focus in this section is to measure dietary diversity for women as a proxy for the nutrition of their households, while this research is focused on women as farmers rather than household nutrition providers. We chose to exclude the women's empowerment section from the Human and Social Values element because the TAPE's focus is to measure women's levels of agency and inclusion within broader agricultural systems, while this research is focused on women's management choices within their own operations. We added an elder empowerment index that mimics the youth empowerment index because we viewed the inclusion of this segment of the population as important to the Society and Culture dimension in the U.S. We adapted the Governance element to be based on women's knowledge of, and participation in, government programs, which differed from the TAPE items seeking to capture the acceptance and participation of women on farms in government programs.

Participant Selection and Data Collection

Fourteen professional food and farming networks from regions throughout the U.S. were contacted to distribute the survey through their social media or listserv outlets. The surveys were distributed

Table 1. Framework Organizing Dimensions, Elements, and Indicators to Assess Participants' Alignment with Agroecology

Dimension	Agroecology Elements	Original Criteria of Performance	Indicators Adapted for Use in This Study
Economy	Diversity Recycling Resilience Circular and Solidarity Economy	Productivity Income Value added	Products, business models, land access, income sources, consumer relationships, success metrics
Environment	Diversity Synergies Efficiency Recycling Resilience	Agricultural biodiversity Soil health	Crop biodiversity, animal integration, soil management, pest management, water management, waste management, input procurement, chemical usage
Society & Culture	Co-creation and Sharing of Knowledge Human and Social Values Circular and Solidarity Economy	Women's empowerment Youth employment opportunity	Information-sharing, relationships with other farmers, opportunities to engage young people under 18 years old on the farm, opportunities to engage older people above 65 years old on the farm
Health & Nutrition	Culture and Food Traditions	Exposure to pesticides Dietary diversity	Presence of traditional food culture, presence of regional food culture
Governance	Responsible Governance	Secure land tenure (or mobility for pastoralists)	Familiarity and participation in government programs, barriers experienced, supports desired

Note: The Food and Agriculture Organzation of the United Nations (FAO) identified the five dimensions to guide sustainable food system development, the 10 Elements to conceptualize agroecology, and the Tool for Agroecology Performance Assessment to measure agroecology (FAO, 2019; Mottet et al., 2020).

electronically from November 2020 to January 2021 and generated 75 usable responses. The total number of women farmers who received the invitation to participate is unclear due to the snowball nature of the distribution, so a percentage response rate cannot be estimated (Naderifar et al., 2017).

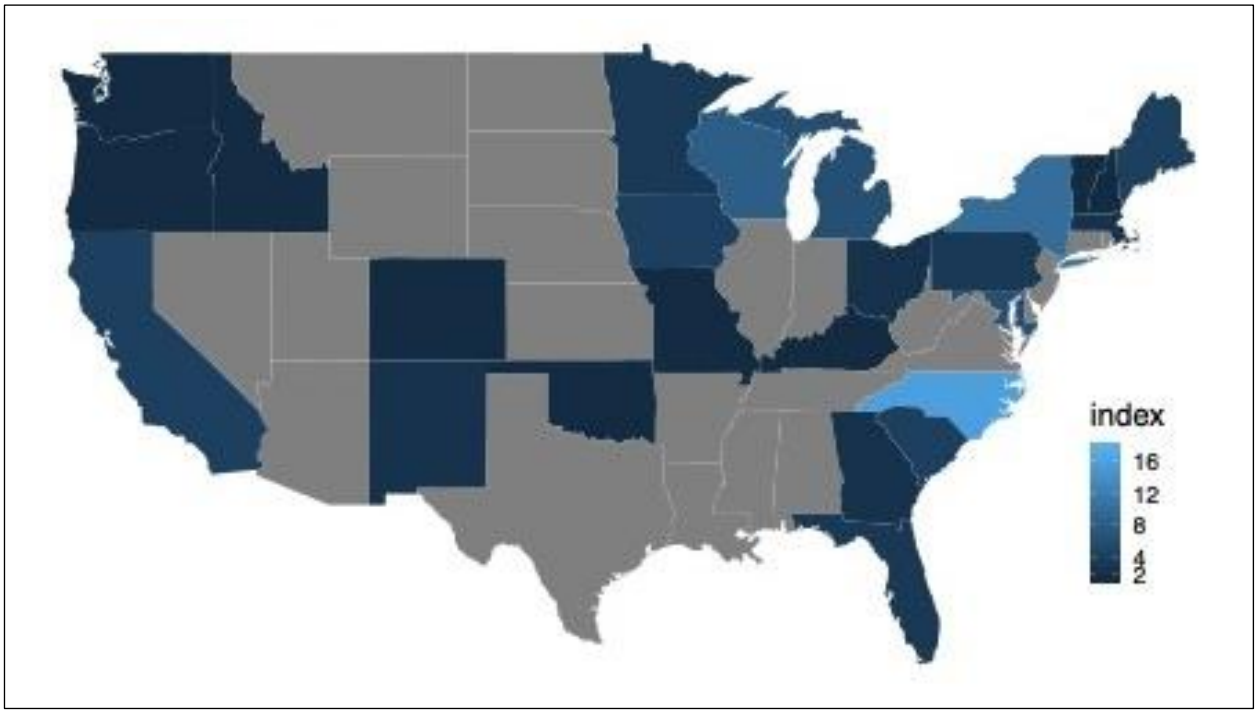
The semi-structured interviews were conducted as follows. Selection criteria were that participants had to identify as women, have practiced farming in the U.S. for at least two years, and occupy a leadership role in a farming enterprise. These criteria were broader than the survey criteria to include women engaged in leadership roles as farmers, growers, and food producers who may not readily identify as primary farm decision-makers. For example, some of the women identified professionally as executive directors or entrepreneurs, or with their additional off-farm job. A broad approach for interview participants allowed for a better understanding of the nuances in the current landscape of women farmers. To identify participants for interviews, women farmers were invited through convenience sampling, snowball sampling, and direct outreach on social media. Interview data were collected from 12 participants from October 2020 to December 2020. Each interview lasted between 45 minutes and one hour. Table 2 lists a descriptor of interview respondents, what they produce, and their geographic community type.

The geographic distribution of all 87 study participants is shown in Figure 1 by state and frequency, with most participants from North Carolina because we were based in North Carolina and had easier access to local outreach networks. Most participants were 30–39 years old (39%), followed by 40–49 years old (20%), 60 or older (19%), 50–59 years old (14%), and 20–29 years old (8%). Eighty-two percent of participants identified as White, while 6% identified as Latina, 6% as Native, 5% as Black, and 1% as Asian. Most participants lived in rural communities (62%), followed by sub/peri-urban (27%) and urban (11%) communities. In this study, "sub/peri-urban" is used to describe a zone of transition between rural and urban areas (UNESCO, 2021). Nearly three quarters of participants (74%) farmed on less than 50 acres (202 hectares) of land. Half of the respondents farmed with a male partner or spouse, and 57% owned their farmland as the sole owner or with a spouse, through their family, or through other co-ownership arrangements.

Table 2. Descriptions of 12 Interview Participants by Professional Title, Product, and Community Type

ID	Professional Title	Products	Community Type
F1	Farmer	Flowers	Rural
F2	Entrepreneur Teacher	Seedlings Education programs	Urban
F3	Entrepreneur Teacher	Seedlings Education programs	Urban
F4	Part-time farmer Executive director, NGO farming network	Vegetables	Sub/peri-urban
F5	Farmer Scientific researcher	Vegetables	Sub/peri-urban
F6	CSA farmer	Eggs, meat, and vegetables; organic	Sub/peri-urban
F7	CSA farmer	Heritage pork, poultry, and eggs	Sub/peri-urban
F8	Farmer	Specialty potato varieties	Rural
F9	Member of an organic farm collective	Tomatoes	Sub/peri-urban
F10	CSA farmer on farming collective	Vegetables; organic	Rural
F11	CSA and market farmer	Vegetables	Rural
F12	Executive director of farm	Vegetables; Community education	Urban

Figure 1. Frequency of All Participants by State



Data Analysis

Survey data were initially explored through Qualtrics bar charts, descriptive statistics, and crosstab queries. Analyses of variance were performed as generalized linear models in R version 4.0 on quantitative survey data to assess the effect of farm size and geographic locations of farms. Geographic locations were defined along the Natural Resource Conservation Service (n.d.) regional boundaries within the USDA. Specifically, the Northeast region included Maine, Maryland, Massachusetts, New York, New Hampshire, Pennsylvania, and Vermont; the Southeast region included Florida, Georgia, Kentucky, and North and South Carolina; the Central region included Iowa, Oklahoma, Michigan, Minnesota, Missouri, and Wisconsin; and the West region included California, Colorado, Idaho, New Mexico, Oregon, Washington. Spearman rank correlation coefficients (ρ) were computed on Likert-scale rankings. Open-ended survey data was imported to NVivo qualitative research software for thematic coding and word frequency analysis. Data were analyzed through word frequency and matrix queries. Interviews were recorded and transcribed, and transcripts were uploaded to NVivo for coding and analysis. Coding was done over three phases: key dimension, agroecology element, and emergent themes.

The 10 Elements of Agroecology were computed by aggregating survey questions per the FAO rubric. For each element, we computed indices using the rubrics outlined in the Mottet et al. (2020) appendix, which assesses each index on a scale of 0 to 4. Where appropriate, scoring of the rubrics was adjusted for available data because the study was in the U.S., a high-income nation, and centered on women, as described above. Synergies focused on crop-livestock-soil integrations because insufficient data was available on landscapes or forests other than orchards. Each agroecology element was examined for interactions between farm size and USDA region as described above.

Results

For each of the five FAO dimensions, we provide an overview of the data collected from the survey and then incorporate the interview data to corroborate the survey data and present emergent themes.

Our results indicate that themes emerging from the in-depth qualitative interview data generally support the quantitative data from the online surveys. The quantitative survey data also suggest that, for some factors, the size of the farm and its geographic location affect women's farm management decisions.

Key Dimension 1: Economy

In the key dimension of Economy, participants were asked to explain how they measured and defined success, and to describe their products, business models, and sources of income.

Farmer Motivations and Metrics for Success

Participants were asked to indicate their motivations for becoming farmers and their metrics for conceptualizing success. Eighty-four percent of women surveyed indicated that they were motivated to become farmers to grow healthy food for their families and/or communities and 71% desired to work outdoors. In an open-ended survey question about how they defined and measured success, the two most frequently used words were "community" (n = 27) and "people" (n = 26). Interview data reinforced social motivators. One farmer (F11) described success as "feeding ourselves, and sharing what we have and our knowledge with the greater community." Other interviewees described success as a combination of social, economic, and environmental indicators. For example, F9 stated, "We're not wealthy, we're not looking at being the most profitable. We're looking at using the best ecological processes and taking care of people." These responses show that producing food that feeds their families and communities is a prominent motivator for these women farmers.

Income Sources and Sales Models

While 24% of participating farmers derived all their income from product sales, the remaining farmers derived income from other sources that included off-farm employment, grants, social programs, property rental, retirement income, and scientific research in affiliation with a university (Figure 2). Income sources relate to farm size (Figure 3). As farms increase their size toward 100 acres (40 hectares), they decrease their utilization of off-farm employment. The smallest farms (≤10 acres, or 4 hectares) most utilized off-farm employment and grants in addition to product sales. Farms with 11–50 acres (4–20 hectares) were most likely to utilize agritourism and education with product sales and off-farm employment, and farms with 51–100 acres (21–40 hectares) relied most heavily on product sales.

Survey respondents mostly used combinations of direct sales models in their local communities to sell their products, such as farmers markets, CSAs, farm stands, restaurant contracts, and online farm sales. Figure 3 shows the distribution of sales model by farm size. The smallest farms (≤10 acres) most utilized CSAs and farmers markets. Midsize farms (11–100 acres) used online sales, farmers markets, and direct sales from farm stands, and the largest farms (101+ acres) sold to grocery stores or other centralized purchasers. Thus, the data show that 100-acre farms or smaller, which were 90% of participants in this study, typically utilize direct-to-consumer sales models.

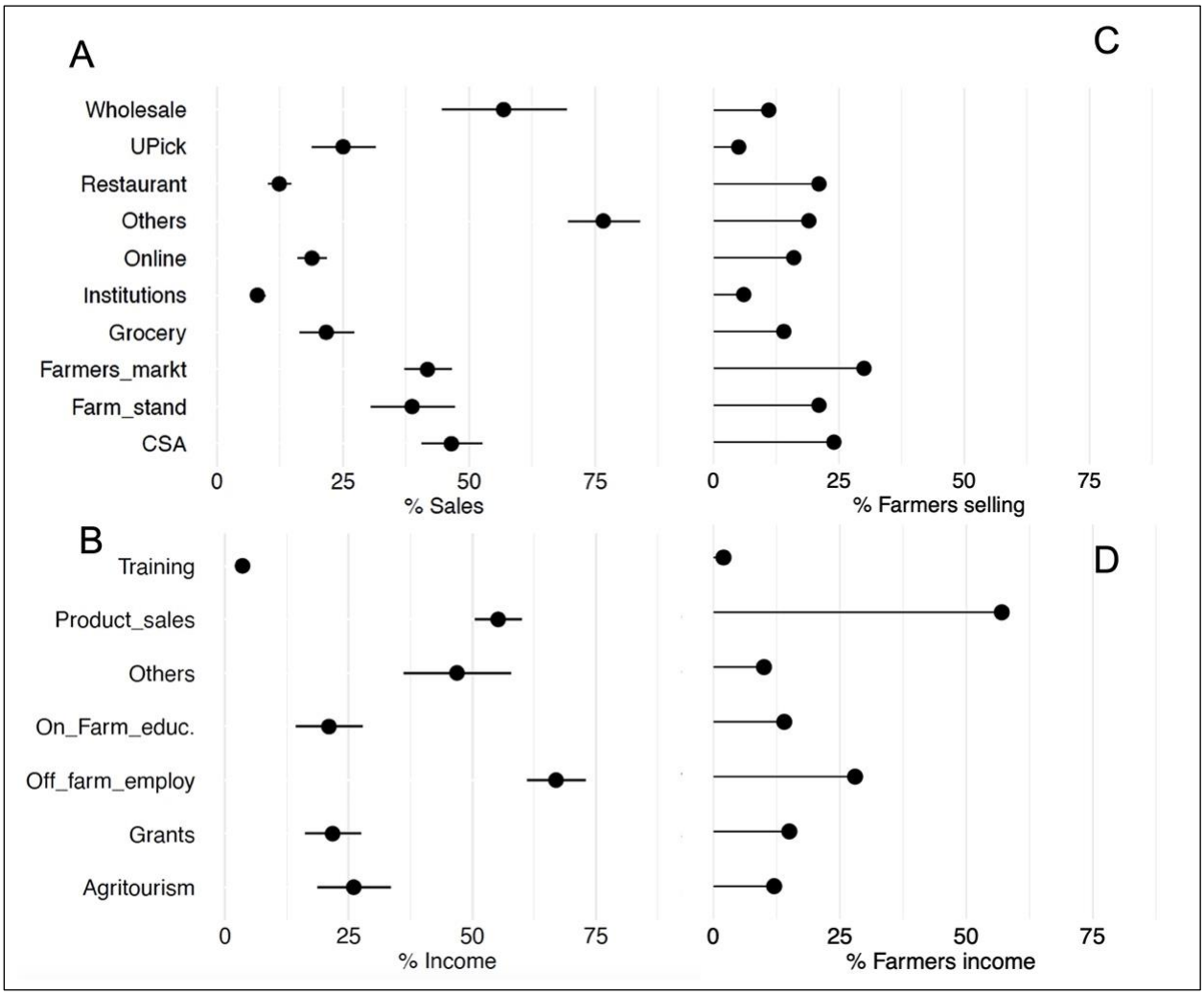
Inclusive Economic Practices

The interview data indicated that the women incorporated practices into their farming businesses that responded to the financial needs of the community. Four strategies emerged: sliding scales, workshares, donations, and accepting government nutrition benefits. Seventy-five percent of interviewees, along with 23% of survey respondents, indicated that they incorporated one or more of those practices into their business models. One farmer (F8) explained her sliding scale approach to selling her products:

> I say [to customers] that a quart is normally [US]$4 but it can be anywhere from [US]$2 to [US]$6—you pay what you can afford. The majority of my customers either give me what I'm asking or they give me more, and that allows me to lower my prices for somebody who might need it. But it's actually helping me either break even on those individual sales or earn more than I expected.

Twenty-five percent of interviewed farmers described using a workshare CSA model to

Figure 2. Income Sources and Sales with Proportion of Surveyed Female Farmers Using Them

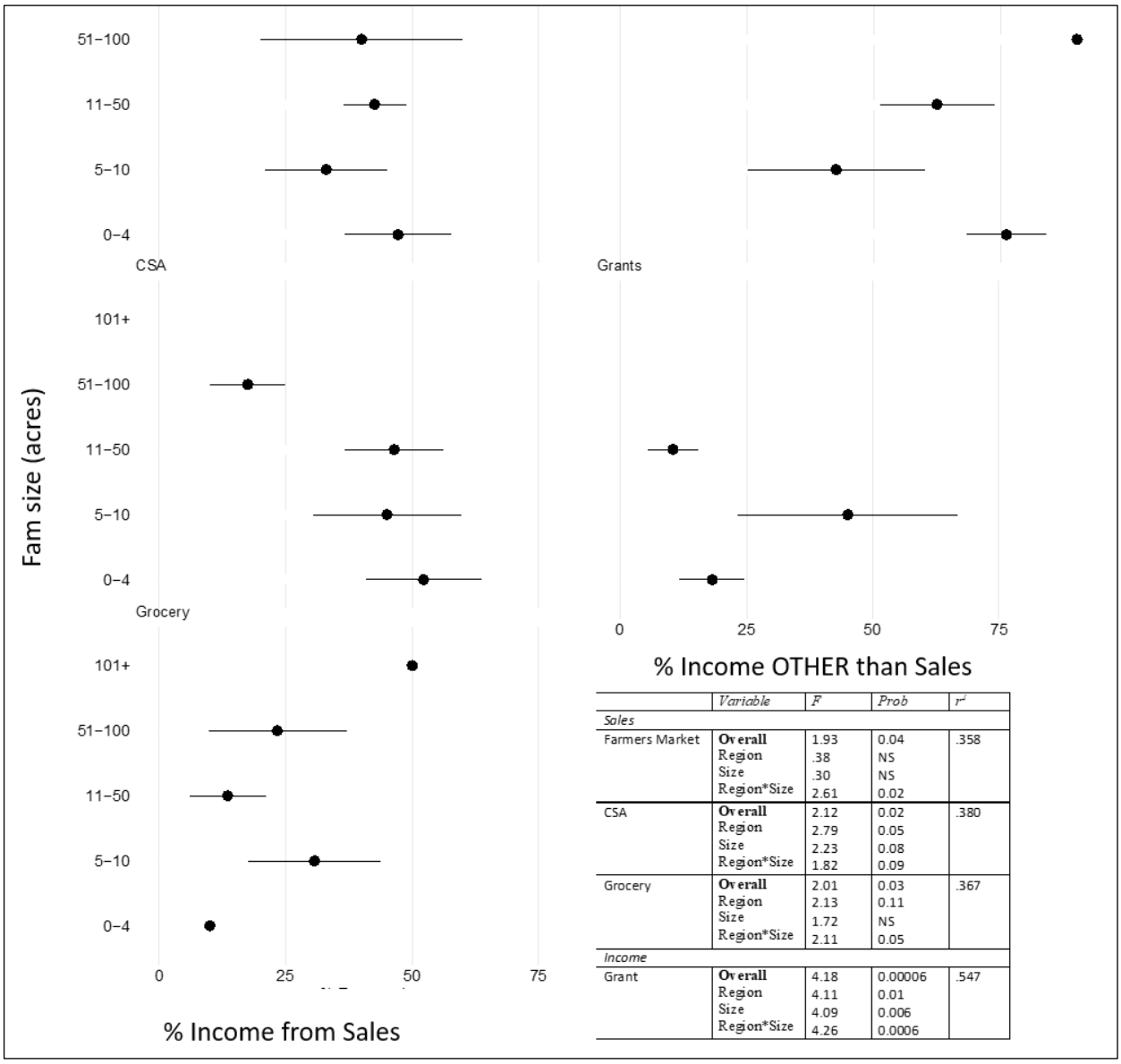


Note: The proportion of different avenues for sale of farm products (A) and other sources and activities for income sources and activities (B) is shown along with the proportion of farmers using them (C for sales and D for income). For A and B, circles indicate mean +/- the standard error of the mean (bars).

exchange food for labor. One farmer (F11) asks for two hours per week of labor in exchange for the wage equivalent in vegetables, while another (F10) offers workshares to local college students. This arrangement is mutually beneficial because people who might not be able to afford a CSA share can obtain fresh produce while the farmer can obtain labor. F11 described the community response to her workshare program as "overwhelming," noting that older rural residents were particularly interested.

Another 25% of interviewees built community donation into their business model. F1 describes the satisfaction she derives from her flower donation program: "[We donate to] all the schools, for teachers' events, hospice care, the ASPCA. Just to be able to have something to give back to the community is priceless." F9 lives on a farm collective in a peri-urban community that allocates produce weekly for donation to food banks. Her farm also runs a pick-your-own operation that asks customers to donate 20% of the produce picked. On F12's urban farm, she reserves 10% of produce for donation by designating community beds for people to harvest food as needed.

Figure 3. Effect of Farm Size on Percentage of Income Derived from Sales and Other Sources by Farm Size for Women Farmers Surveyed



	Variable	F	Prob	r^2
Sales				
Farmers Market	**Overall**	1.93	0.04	.358
	Region	.38	NS	
	Size	.30	NS	
	Region*Size	2.61	0.02	
CSA	**Overall**	2.12	0.02	.380
	Region	2.79	0.05	
	Size	2.23	0.08	
	Region*Size	1.82	0.09	
Grocery	**Overall**	2.01	0.03	.367
	Region	2.13	0.11	
	Size	1.72	NS	
	Region*Size	2.11	0.05	
Income				
Grant	**Overall**	4.18	0.00006	.547
	Region	4.11	0.01	
	Size	4.09	0.006	
	Region*Size	4.26	0.0006	

Note: Data shows mean (circle) +/- standard error of the mean (bar). Farm size (acres) was shown to significantly affect the type of sales and income revenue for female farmers. The box insert shows significant statistical values. Only income sources from sales and others that were statistically affected by farm sizes are shown.

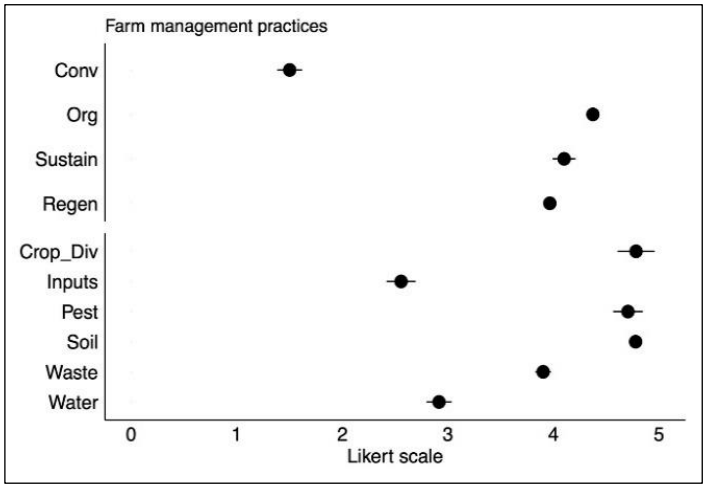
Key Dimension 2: Environment

Questions in the key dimension of Environment relate to agricultural biodiversity, soil health, water, and climate change mitigation. Participants were asked to evaluate the levels of crop diversity on their farms and how much they would identify their practices as conventional, organic, regenerative, or sustainable. They were also asked to assess their management practices on an agroecological scale.

Management Practices

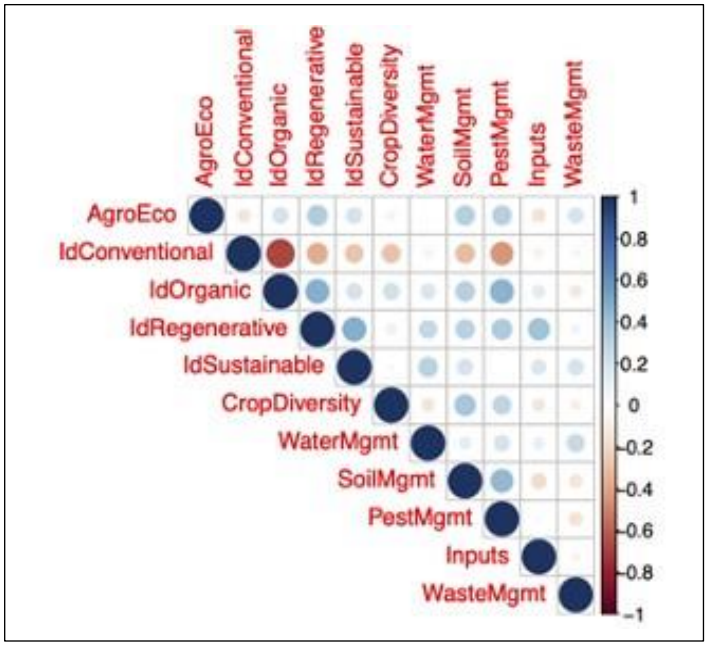
When asked about the degree to which they identify with different agricultural approaches on a

Figure 4. Survey Respondents' Self-Evaluation of the Agroecology of Their Management Practices



Note: Likert scale ranged from 0 (no knowledge/no practice) to 5 (fully knowledgeable/fully agroecological practice). Data shows mean (circle) +/- standard error of the mean (bar). The different types of farm management practices on the y axis refer to the degree of use from none (0) to highly integrated (5) and are water resource (water harvesting and saving techniques used), waste management (farm residues reused and recycled), soil (synthetic vs. organic practices used), pest (chemical used vs. biological control), types of inputs (market purchased vs. exchanged or produced onsite), crop diversity (monoculture vs. highly diversified). The y axis also refers to their assessment of the type of management used generally, whether conventional, organic, regenerative, and sustainable methods, as described by the USDA.

Figure 5. Correlation Matrix of Self-Evaluation Scores for Environmental Management Practices



Note: See Figure 4 for description of abbreviations.

scale of 0–5, respondents most strongly identified as organic followed by sustainable and regenerative, while the fewest participants identified as conventional (Figure 4). However, responses about conventional agriculture were dependent on USDA regions ($F=2.78$, $p\leq.05$), marginally interacting with farm size ($F=1.78$, $p\leq.1$) where farms of 51–100 acres in the Southeast were more likely to identify with conventional agricultural practices. Respondents evaluated themselves as having strong crop diversity, agroecological soil management, and sustainable pest management practices (Figure 4). However, they evaluated themselves lowest for agroecological water management and input procurement.

The farmers' identifications for agricultural approaches were correlated with their management practices (Figure 5). Strong correlation coefficients were found between those who identified with organic and regenerative farming ($\varrho=0.472$), regenerative and sustainable farming ($\varrho=0.477$), and organic and agroecological pest management ($\varrho=0.469$). A strong correlation exists between soil management and pest management scores ($\varrho=0.433$). Identifying as regenerative moderately correlates with practicing agroecological input procurement ($\varrho=.39$).

Animal Integration

Survey data indicate a relationship between farm size and the presence of animals. Farms between 11 and 100 acres have the greatest presence of cows, pigs, goats, sheep, and chickens. Interviewees described the critical role played by animals in their production processes. For two interviewees, meat production was part of their farm model. In addition to producing meat products for sale, these farmers integrated the animals into their soil management by rotating them in fields between crops. The animals' grazing and movement aerated the soil and managed weeds, and their manure fertilized the soil. One farmer (F7) stated,

> My whole approach is letting animal power run my farm, utilizing the lands effectively with those animals, and then producing something that is so holistic to the whole picture that a little bit goes a long way. The flavor and quality [of my meat products] is unsurpassed.

Soil Building as Soil Management

Seventy-five percent of interviewees mentioned at least one of five agroecological soil management practices: cover cropping, crop rotation, compost application, animal manure integration, and humanure (human waste) integration. For two farmers, "healing" or "rebuilding" soil is an explicit objective of their farms. F5 said, "I want to find a space, heal it, design the system, make sure that it is up and running, and then find another space and do the same thing somewhere else." F8 describes her philosophy of soil building as an investment in the future. She said,

> I'm trying to get the organic levels in the soil back up. We're trying to be no-till, and we are almost there. It takes a long time. I've learned that, in order to have something healthy like no-till, you often need a healthier environment to start with. You can build those healthy environments, but this is all an investment in the future. This is why people get frustrated with organic, because for the first couple years it might work, but it's going to take 10 or 20 years before you're seeing the radical beautiful amazing results that you see in the books.

Key Dimension 3: Society and Culture

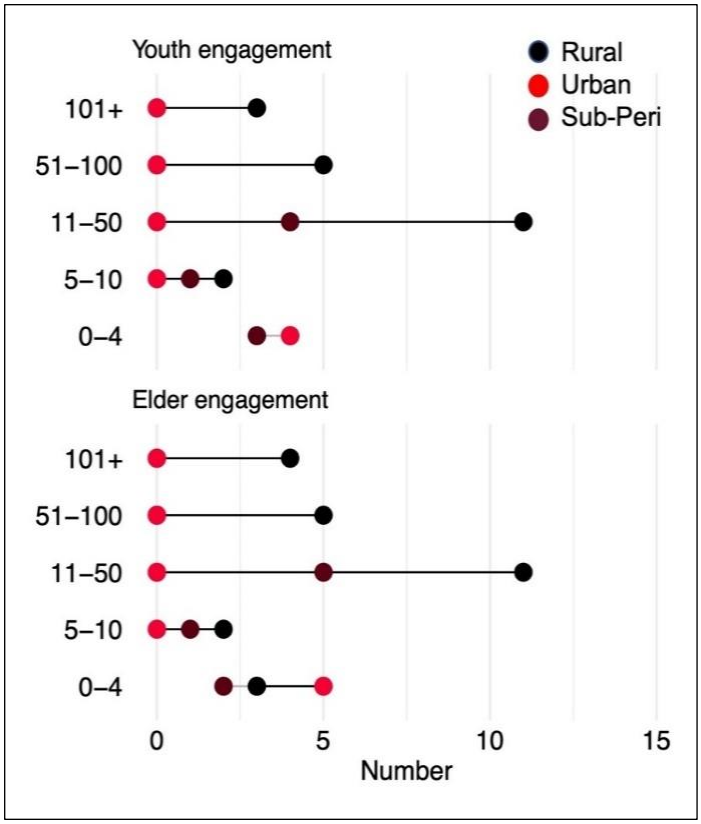
Questions in the key dimension of Society and Culture relate to social relationships through the inclusion of younger people and older people on the farm, and relationships with other farmers.

Opportunities to Engage Younger and Older People

Half of the survey respondents offered opportunities for young people (51%) and/or older people (53%) to participate on their farms. Rural farms were particularly likely to incorporate opportunities for older and younger people, as shown in Figure 6.

In the interviews, eight out of 12 interviewees indicated that providing opportunities for intergenerational participation through engaging younger and/or older people was part of their farm models. They referenced three strategies: school partnerships, university partnerships, and workshare CSAs. F10 brings young people from a local primary school and a university to her farm. She has arranged for students at the primary school to visit the farm weekly for work and play. This farmer also partners with the local university to offer farm work opportunities, arranging for students to use their meal plans to purchase CSA shares. On her urban farm, F12 emphasizes the inclusion of elderly people in her programs. She says,

Figure 6. Frequency of Offering Opportunities to Engage Participation of Older and Younger People by Community Type Among 75 Farms Surveyed



> A lot of our neighborhood is made up of elderly people who purchased their homes in the '40s or '50s and are still here. We're going to build raised beds so that the elderly won't have to bend down. If they want garden beds in their house, we're going to have programs where we'll build them. Most of our Community Association meetings are people in that age range. We go to them every month, and we talk about our project, and people are excited. They remember when their parents had a garden—there's a lot of knowledge.

These programs expand the farms' capacities to serve their communities while broadening their customer bases.

Knowledge-Sharing Enterprises

Eighty-four percent of the study's participants indicated that they teach, train, and share their knowledge with others. The most common strategies referenced by interviewees were to offer workshops and to organize community events. Five interviewees said they encountered barriers to obtaining agricultural knowledge due to their race or ethnicity, gender, or both. These barriers inspired them to create new business ventures. F2 and F3 were motivated to open their own plant nursery because they felt unwelcome in white-owned plant nurseries as Black gardeners. F2 said,

> [Black] people are a lot more relaxed when they're around us and ask us a lot more questions not just from us having a nursery but being interested in gardening for so long. We went to local nurseries, and the way we get treated as customers at some places and the knowledge that we don't gain . . . if we didn't have it or know it, we would just have to look it up.

Another interviewee (F4) felt that her ethnic group was not visible within the farming landscape of the U.S., so she created an organization to develop a community for farmers who share this identity.

> I would meet people who were [in my ethnic group] and farming and they had no concept that the work that they were doing was actually connected to their heritage and their ancestors. We saw this lack of a community as an opportunity and we decided to fill the hole. The more we dig into this work, and the more visible we become, the more we hear from people, "Wow, I've been looking for something like this for so long."

Key Dimension 4: Health and Nutrition

Questions in the key dimension of Health and Nutrition relate to the presence of traditional and regional food cultures. Traditional food refers to food eaten in communities for many generations, and regional food refers to food grown and produced in a particular geographic area.

Regional and Traditional Food Culture

Survey respondents were asked to evaluate the strength of regional and traditional food cultures in their communities on a Likert-scale of 0–5. Respondents indicated a greater sense of regional food culture (mean=3.0) than traditional food culture (mean=2.5). While 12 respondents scored their sense of regional food culture at a 5, zero respondents scored their sense of traditional food culture at a 5. This dearth of traditional food culture is worth noting. Respondents also indicated that food is featured in their communities through the presence of locally owned non-franchised food businesses (72%), farm-to-table restaurants (64%), and festivals (53%), which form the infrastructure for regional food culture.

Food Preparation

Many interviewees viewed the lack of strong food culture as a business opportunity. In addition to growing food, these women teach food preparation and host farm-to-table meals. The food workshops and experiences target a range of consumers. F11 has written proposals for her local Cooperative Extension office to develop cooking classes because she noticed the erosion of cooking skills in her community. She attributed this issue to a lack of time and the inability to afford whole foods, noting that exhaustion and time scarcity make people more dependent on cheap pre-prepared food. F7, meanwhile, offers gourmet food experiences

that target high-income consumers. She grows heritage meats and leads cooking demonstrations that teach customers to use different cuts. By combining global culinary traditions with community events, this farmer has created a vibrant business. She said,

> The farm is the site of these big gatherings like a whole goat roast. We do it by donation or we sell tickets, but we do these themed events on the farm. People then can come and see the animals, see how they're raised, enjoy what we've pulled together at the butcher shop. It's a full embracing of culinary traditions from all over the place. People will ask us to make scrapple from Philadelphia, and I'm like, "Sure, we'll do that."

Other interviewees described how teaching food preparation was part of their work. F9 built a partnership between her farm collective and the local elementary school. At the school, teachers incorporate the farms into the curriculum, and the lunchroom celebrates local farmers and connects them to the food being served. F12 offers food preparation education on her urban farm in response to the need in her community. When she distributes produce at her market stand, she answers questions and offers ideas for preparing the vegetables. This approach, she said, has the dual function of building relationships and teaching cooking skills.

Key Dimension 5: Governance

Questions in the key dimension of Governance relate to how participants have engaged with government services, the barriers they experience, and the supports they would like to be provided by the government.

Engagement with Federal Programs

The U.S. government offers federal programs to help farmers nationwide. About half (53%) of survey respondents indicated that they have received support from the federal government. The programs with the highest participation rates were the National Organic Program (21%), coronavirus assistance program (19%), nutrition programs (16%), conservation programs (10%), loans (9%), and crop insurance (8%). Program participation related to farm size. The smallest farms utilized the Supplemental Nutrition Assistance Program (SNAP) more than the largest farms, though it is unclear how many use the program as a recipient or as a vendor.[2] All farm sizes utilized the National Organic Program and the conservation programs evenly, and only the largest farms used crop insurance programs. While nearly half of survey participants (47%) described their farming practices as organic, only 21% participated in the National Organic Program. F6 chooses not to participate in the National Organic Program despite practicing organic farming because she says it does not add value for her. Because she operates a CSA for her local community, she says that trust and transparency in her methods function in place of the government label, and she views the program as valuable only for distribution at a national or international level.

Public Valuation of Food as the Biggest Income Barrier

For survey respondents, the most common barrier they experienced was income (27%). This barrier encompasses responses such as the low value placed upon food by consumers, the discrepancy between the high value of land and the low value of food, and farmers' ability to earn a living wage. Interviewees reinforced the idea of the barrier presented by Americans' low valuation of food. F10 said,

> I wish people would value their food more. I think the U.S. only spends 6% of their income on food, while other countries do 20% or 30%, 50%, depending on where you are, how poor you are. And there's so much waste here—food waste, in production and in the fridges of people. I think it's 30 or 40% that the U.S. wastes on food. So we're supposed to

[2] The Supplemental Nutrition Assistance Program provides publicly funded nutrition benefits to eligible families with limited income and resources in the United States (USDA FNS, 2021).

> produce super cheap, and then consumers don't care because it's so cheap. Then we can't make a living.

Government Support Desired: Infrastructure and Resources for Small Farms

Participants were asked to indicate their requests for government support. The largest category of requests related to programs that center the needs of small farms instead of large corporations (31%). Participants requested grant programs for farmers to develop infrastructure, build online platforms, and access markets. They requested subsidies to raise wages for farm labor and to implement regenerative practices. Lastly, they sought relief for healthcare, childcare, and student loan expenses. Interviewees praised existing government programs that served these functions. F8 referred to a state program that helped her, saying

> [My state] has a program—if you graduate from any university or college and within 2 years agree to farm in [that state] for 5 years, they will pay off all of your student loans up to $50,000. I received that, so I have had far fewer financial burdens than your average young farmer coming out of college.

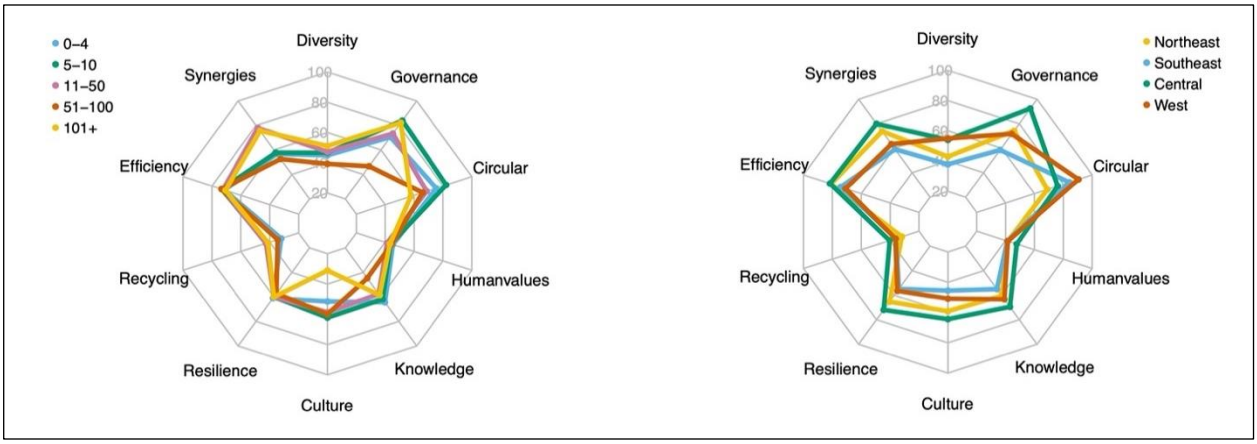
The 10 Elements of Agroecology

In line with FAO criteria, indices that compose the 10 Elements of Agroecology were used to integrate survey responses of women farmers. Each element was analyzed by farm size and by USDA region as shown in Figure 7. Overall, the Synergy, Governance, Circular Economy, and Efficiency were the highest and ranged between 68% $\pm$ 3 (Synergy) and 74% $\pm$ 1 (Efficiency) compared to Recycling and Human and Social Values, which were the lowest (42% $\pm$ 2 for Recycling and 47% $\pm$ 2 for Human and Social Values). Of the 10 elements, general linear models that included both farm size and region were significant for Synergy and Governance ($p \leq 0.03$ and $p \leq 0.005$ for Synergy and Governance, respectively). Furthermore, farm size significantly affected these indices ($p \leq 0.03$ and $p \leq 0.02$ for Synergy and Governance, respectively), where farms of 51 to 100 acres had lower indices than larger farms or smaller ones. Only Governance showed a significant interaction between farm size and region ($p \leq 0.02$) because the farms located in the southeastern region were less likely to use government programs. Recycling was only marginally affected ($p \leq 0.08$) by both factors because of the interactions between farm size and region ($p \leq 0.02$). No significant effect of region or farm size was found in other indices.

Discussion

This study sought to examine the practices and approaches of women farmers throughout the U.S.

Figure 7. Effect of Farm Size and Region on the 10 Elements of Agroecology



Note: Each line represents average values per category. Analysis of variance for the combined farm size (acres: left panel) and USDA regions (right panel) showed significant effects for Synergy ($p \leq 0.03$) and Governance ($p \leq 0.005$), while Recycling was marginally significant ($p \leq 0.08$).

and how those practices and approaches align with the FAO's Elements of Agroecology. Studies in developing countries demonstrate that women farmers are leaders of agroecology projects due to their capacity for organizing social networks, and their roles within families and communities. We hypothesized that women in the U.S. would also be leaders of agroecological farming projects. We found that the majority of women whom we surveyed and interviewed were leaders of agroecological projects that provide direct nutritional, educational, environmental, and social services to their communities in alignment with several elements of agroecology.

Women Farmers in the U.S. and Agroecology

The women in this study were motivated to become farmers by a desire to grow food for their families and communities and to work outdoors, in alignment with findings from prior studies (Bregendahl & Hoffman, 2010; Chiappe & Butler Flora, 1998; Wells & Gradwell, 2001). Consistent with findings in Pennsylvania from Trauger et al. (2009), these women farmers utilize direct sales models and offer education and experiences as products, thereby fostering locality-based food systems. Also consistent with findings from Trauger et al. (2009), participants throughout the U.S. measured success through metrics related to caring for their communities and caring for land in addition to profit and productivity. These motivations and values undergird the structure of farm models that nourish, educate, and connect local communities while stewarding natural resources.

Small Diversified Farms for Local Consumption

Consistent with census data since 1978, these women farm on smaller acreage than the national average. Ninety percent of the participants farm on 100 acres (40 hectares) or less compared to the national average farm size of 444 acres (179 hectares; USDA NASS, 2020). The women in this study produce vegetable, flower, and animal products that they sell through direct-sales models to their local communities. The diversified direct-sales farm model aligns with the FAO's agroecology elements of Diversity, Resilience, Culture and Food Traditions, and Circular and Solidarity Economy. The utilization of direct-sales models is consistent with the finding from Ahearn et al. (2018) that women in the U.S. are more likely to use direct marketing channels than their male counterparts. Direct sales strengthen localized food chain relationships for increased resilience, which proves particularly valuable during disturbances such as the COVID-19 pandemic, as shown by Tittonell et al. (2021). Localized relationships are also valuable for providing nutrition assistance to food-insecure populations. The income streams of the participating farms were diversified between product sales, social programs, and grants, with increasing reliance upon product sales as the farm size surpassed 50 acres. The urban farms relied particularly on grant-funded social programs for income. By offering social programs to local communities, farms strengthen social networks and accrue social capital, thereby increasing producers' ability to reach consumers—particularly those who are marginalized—and provide them with access to healthy food. Providing both products and services also diversifies farm income streams for increased economic resilience.

Social Programs to Educate and Connect Communities

Eighty-four percent of participants teach, train, and share their knowledge with others, and about half of participants offer opportunities for intergenerational engagement with younger and/or older people. These social programs include culinary workshops and events, workshares, and work days for children, youth, or other community members. These programs connect people with nutritious food and food-related skills and knowledge while building community. The social programs align with the FAO's agroecology elements of Co-creation and Sharing of Knowledge, Human and Social Values, Culture and Food Traditions, and a Circular and Solidarity Economy. These programs capitalize upon the farm as a space to generate knowledge and build community in addition to produce food (Di Masso et al., 2022; Trauger et al., 2009). By building connections with schools and universities, farmers support the integration of food and agriculture into the curriculum. This knowledge transmission infrastructure has economic value because it fosters future generations of

farmers and food professionals in addition to strengthening public health (González De Molina & Lopez-Garcia, 2021). Some participants referenced gaps and barriers related to their local food and agriculture economies that they used as opportunities for innovation, extending nationally the findings from Trauger et al. (2009) for the state of Pennsylvania.

Care for Reproductivity of Environmental Resources

Efforts to heal land and rebuild soil contribute to sustaining natural resources, maintaining living ecosystems, and investing in long-term productivity. These practices align with the FAO's elements of Diversity, Synergy, Recycling, and Resilience as well as the feminist economic values articulated by Di Masso et al. (2022) of care provision and reproductive work. Respondents indicated using practices for soil stewardship in accordance with agroecological management such as capturing organic waste as fertilizer, applying cover cropping and crop rotation, and integrating animals for tillage, weed management, and fertilizer. However, though the federal government offers programs to incentivize natural resource conservation, only 10% of these women participate. Increasing the participation rate of women farmers in federal natural resource conservation programs would provide women with resources to expand their capacity to practice agroecological farming.

Respondents indicated their lowest level of confidence in agroecological water management and input procurement practices. One interviewed farmer referenced water management practices for farming in the desert that she learned from her grandfather in Mexico. These findings on knowledge gaps and traditional knowledge are useful to inform strategic planning for conservation outreach and training programs. Prior research has shown that women are likely to acquire and implement conservation practices due to their social networking and knowledge-sharing practices (Barbercheck et al., 2014). By targeting training about water management, input procurement, and traditional Indigenous farming techniques to women, conservation outreach programs would expand their impact for effecting an agroecological transition.

Alternative Economic Models from Women-Led Farms

The women-led farm models described in this study face considerable challenges. Such challenges are consistent with the case study about farm closure by Dubisar and Slocum (2022), which provides an in-depth examination of a woman's decision to close her small, diversified direct-sales vegetable farm. The researchers emphasize that farmers decide to leave farming for several reasons that relate to finances, burnout, boredom, and identity shifts. Dubisar and Slocum (2022) encourage farmers to share their farm-closure stories to illuminate the systemic challenges facing small-scale regional food production. To address these challenges, Dubisar and Slocum propose reconceiving small-scale farmers as public service providers similar to teachers or healthcare workers, and funding them as such. Alternatively, given that 67% of female farmers do not list farming as their primary occupation (compared to 54% of men) and 62% of farms run by women earn under US$10,000 (compared to 54% of farms run by men), there may be value to expanding the practice of farming as a temporary or additional occupation (USDA NASS, 2019). A farm model in which farming is not the only source of income during one's lifetime has value in terms of economic resilience. Providing publicly funded infrastructure for temporary or shared use of land and equipment would encourage the expansion of these models of farming.

The Role of Farm Size

This research indicates a relationship between farm size and business model, environmental practices, and social value. Further research into the relationship between agroecology and farm size would be useful. We do not suggest that the farm models described by this study are the exclusive solution to food provision in a national agroecological transition. Rather, they are components of a diverse portfolio of food production enterprises that serve different functions, communities, and needs. Small urban farms gather community and promote food security, and midsize diversified peri-urban farms operate CSAs and contract with local restaurants and institutions, while large farms are best suited

for the production of regionally dependent crops such as grain and fruit. Understanding how women practice farming—by emphasizing local nutrition, environmental care, and education—and the value that women farmers offer to different communities would support policies that expand gender equality in agriculture throughout the nation.

Limitations

Given the exploratory nature of this study, these findings may not be representative of all women farmers in the U.S. and warrant further investigation about key findings. In comparison to the most recent Census of Agriculture data of women farmers nationwide, the sample in this study has an overrepresentation of smaller farm sizes that use organic methods and direct sales models. For example, 75% of study participants farmed on 50 acres or less compared to 48% of women nationally who farm at 49 acres or less (USDA NASS, 2017). In addition, this study had an extremely small sample size of women who farm on more than 100 acres (8%) while at the national level, 24% of women farm on 180 acres or more (USDA NASS, 2017). While 47% of participants identified as farming organically, only 1% of women farmers on record through the census use organic methods. While 90% of participants use a direct-sales model, only 8% of women nationally sell directly to consumers (USDA NASS, 2017).

Several possible explanations for these discrepancies are worth noting. First, the presence and role of female leadership on farms is complex to delineate. At the national level, any farm with one woman on an operating team is considered to be female-led. The differences between farms led exclusively by women, farms led in partnership with men, and farms led by women along with a majority of men may make different operating decisions. Because the survey participants and interviewees were identified through farming social networks, they capture a demographic of women farmers that differs from the demographic captured by the census. In addition, the number of women in the study who chose to certify as organic was far lower than the number of women who self-identified as organic farmers, showing that the number of certified organic farmers documented in the census is not representative of all farmers who practice organic farming. The same gap may apply between farmers who report practicing direct sales models in comparison to farmers who self-identify as practicing direct sales models.

Conclusion

This research study sought to gain understanding about how women practice farming in the U.S. in relation to the FAO's Elements of Agroecology. We found that the participants were motivated to farm by a desire to produce food to feed their families and communities. The majority operated farms on under 100 acres that grew diversified products that they sold directly to consumers. Participants used strategies to extend food access to low-income consumers, to teach food growing and preparation skills, and to engage younger and older people in farm activity. Survey respondents indicated the strongest confidence levels in practicing agroecological soil and pest management and the lowest confidence levels for practicing agroecological input procurement and water management. Finally, farm size and region were significant for the presence of agroecological management practices. These features of farming enterprises led by women in the U.S. offer value when considering investments in an agroecological transition. Similar to women in low-income countries, our data on women farmers in the U.S. highlight women's key role in the transition to sustainable agriculture in high-income countries. This research posits that an agricultural landscape built upon gender equality in the U.S. would lead to increased nutrition, knowledge, and cohesion for communities, as well as stewardship of soil and water resources. These women-led farm models connect to Gliessman's five levels of transformation from industrial agriculture to agroecology. They provide blueprints for redesigning agroecosystems in Level 3 and re-establishing direct connections between growers and consumers in Level 4 to make progress toward achieving the global food system of Level 5 that is built upon equity, participation, democracy, justice, and the restoration and protection of life on earth (Gliessman, 2016).

The women-led farm models described by this study are important pieces within a portfolio

of food production enterprises designed to serve different functions, communities, and needs. While this study is not representative of all women farmers, it provides insight about the unique value contributed by women farmers to the U.S. This insight can inform policy, planning, and programs that support gender equality and an agroecological transition in the U.S. in partnership with global efforts to build sustainable food systems. Further research that captures the impacts of sexuality, nonbinary gender identities, and intersectionality on farm management practices would be useful to advance understanding of the value of an equitable, inclusive, and diverse agricultural landscape. Additionally, research to explore the effect of farm size on agroecological management practices, and regional differences in agroecological management would be beneficial to facilitating an agroecological transition.

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References

Ahearn, M. C., Liang, K., & Goetz, S. (2018). Farm business financial performance in local foods value chains. *Agricultural Finance Review*, *78*(4), 470–488. https://doi.org/10.1108/AFR-08-2017-0071

Altieri, M. A. (1988). Beyond agroecology: Making sustainable agriculture part of a political agenda. *American Journal of Alternative Agriculture*, *3*(4), 142–143. https://doi.org/10.1017/S0889189300002411

Altieri, M. A. (1989). Agroecology: A new research and development paradigm for world agriculture. *Agriculture, Ecosystems & Environment*, *27*(1–4), 37–46. https://doi.org/10.1016/0167-8809(89)90070-4

Altieri, M., C. I. Nicholls, & Funes-Monzote, F. (2012). *The scaling up of agroecology: Spreading the hope for food sovereignty and resiliency* [Position paper]. Sociedad Cientifica Latinoamericana de Agroecologia. https://archive.foodfirst.org/wp-content/uploads/2014/06/JA11-The-Scaling-Up-of-Agroecology-Altieri.pdf

Anderson, C. R., Bruil, J., Chappell, M. J., Kiss, C., & Pimbert, M. P. (2020). *Agroecology now! Transformations towards more just and sustainable food systems*. https://doi.org/10.1007/978-3-030-61315-0

Ball, J. A. (2020). Women farmers in developed countries: A literature review. *Agriculture and Human Values*, *37*, 147–160. https://doi.org/10.1007/s10460-019-09978-3

Barbercheck, M., Brasier, K., Kiernan, N., Sachs, C., & Trauger, A. (2014). Use of conservation practices by women farmers in the Northeastern United States. *Renewable Agriculture and Food Systems*, *29*(1), 65–82. https://doi.org/10.1017/S1742170512000348

Bensin, B. M. (1928). *Agroecological characteristics description and classification of the local corn varieties—chorotypes*. Publisher unknown.

Bensin, B. M. (1930). Possibilities for international cooperation in agroecological investigations. *International Review of Agriculture. Part 1, Monthly Bulletin of Agricultural Science and Practice*, *21*, 277–284.

Bezner Kerr, R., Hickey, C., Lupafya, E., & Dakishoni L. (2019). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *Journal of Peasant Studies*, *46*(7), 1499–1518. https://doi.org/10.1080/03066150.2018.1547897

Bregendahl, C. & Hoffman, M. (2010). *Women, land, and legacy: Change agents and agency change in Iowa: Evaluation results*. Leopold Center, Iowa State University. http://lib.dr.iastate.edu/leopold_pubspapers/73

Chiappe, M. B., & Butler Flora, C. (1998). Gendered elements of the alternative agriculture paradigm. *Rural Sociology*, *63*(3), 372–393. https://doi.org/10.1111/j.1549-0831.1998.tb00684.x

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209–240). SAGE.

Creswell, J., & Plano Clark, V. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

Dentzman, K., Pilgeram, R., Lewin, P. & Conley, K. (2021). Queer farmers in the 2017 US Census of Agriculture. *Society & Natural Resources*, *34*(2), 227–247. https://doi.org/10.1080/08941920.2020.1806421

Di Masso, M., López-García, D., Clemente-Longás, J., & García-García, V. (2022). Taking food out the private sphere? Addressing gender relations in urban food policy. *Agroecology and Sustainable Food Systems*, *46*(1), 108–132. https://doi.org/10.1080/21683565.2021.1936742

Dubisar, A. M., & Slocum, J. A. (2022). Ending Lacewing Acres: Toward amplifying microperspectives on farm closure. *Journal of Agriculture, Food Systems, and Community Development*, *11*(4), 19–33. https://doi.org/10.5304/jafscd.2022.114.001

Food and Agriculture Organization of the United Nations [FAO]. (2018). *The 10 elements of agroecology: Guiding the transition to sustainable food and agricultural systems*. https://www.fao.org/documents/card/en/c/I9037EN/

FAO. (2019). *Tool for Agroecology Performance Evaluation (TAPE) – Test version: Process of development and guidelines for application*. https://www.fao.org/documents/card/en/c/ca7407en/

FAO. (2022a). *Agroecology knowledge hub: FAO's work on agroecology*. https://www.fao.org/agroecology/overview/our-work/en/

FAO. (2022b). *Agroecology knowledge hub: Overview*. https://www.fao.org/agroecology/overview/en/

FAO. (2022c). *Agroecology knowledge hub: Scaling up agroecology to achieve the SDGs*. https://www.fao.org/agroecology/overview/agroecology-and-the-sustainable-development-goals/en/

Fremstad, A. & Paul, M. (2020). Opening the farm gate to women? The gender gap in U.S. agriculture. *Journal of Economic Issues*, (*54*)1, 124–141. https://doi.org/10.1080/00213624.2020.1720569

Gliessman, S. R. (1997). *Agroecology: Ecological processes in sustainable agriculture*. CRC Press.

Gliessman, S. R. (2015). *Agroecology: The ecology of sustainable food systems* (3rd ed.). CRC Press.

Gliessman, S. R. (2016). Transforming food systems with agroecology. *Agroecology and Sustainable Food Systems*, (*40*)3, 187–189. https://doi.org/10.1080/21683565.2015.1130765

Gomori-Ruben, Lianna (2021). *Agroecology and women-run farms: A case study of women farmers in the United States*. Master's project, Duke University. https://hdl.handle.net/10161/22711

González De Molina, M., & Lopez-Garcia, D. (2021). Principles for designing agroecology-based local (territorial) agri-food systems: A critical revision. *Agroecology and Sustainable Food Systems*, *45*(7), 1050–1082. https://doi.org/10.1080/21683565.2021.1913690

Hoffelmeyer, M., Wypler, J., & Leslie, I. S. (2023). Surveying queer farmers: How heteropatriarchy affects farm viability and farmer well-being in U.S. agriculture. *Journal of Agriculture, Food Systems, and Community Development*, *12*(3), 111–125. https://doi.org/10.5304/jafscd.2023.123.005

Holt-Gimenez, E., & Altieri, M.A. (2013) Agroecology, food sovereignty, and the new Green Revolution. *Agroecology and Sustainable Food Systems*, *37*(1), 90–102. https://doi.org/10.1080/10440046.2012.716388

Hoppe, R. A., & Korb, P. (2013). *Characteristics of women farm operators and their farms* (USDA ERS Economic Information Bulletin No. 111). *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2266538

Inwood, S., & Stengel, E. (2020). Working households: Challenges in balancing young children and the farm enterprise. *Community Development*, *51*(5), 499–517. https://doi.org/10.1080/15575330.2020.1800772

IPES-Food (2018). *Breaking away from industrial food and farming systems: Seven case studies of agroecological transition*. https://www.ipes-food.org/_img/upload/files/CS2_web.pdf

Kalbacher, J. Z. (1985). *A profile of female farmers in America* (Rural Development Research Report No. 45). U.S. Department of Agriculture, Economic Research Service. https://www.montana.edu/empowering-women-in-ag/documents/articles-and-news/A Profile of Female Farmers in America.pdf

Lutzenberger J. (1976). *Fim do futuro? Manifesto ecológico Brasileiro*. Editora Movimento.

Montgomery, D. R. (2007). Soil erosion and agricultural sustainability. *Proceedings of the National Academy of Sciences*, *104*(33), 13268–13272. https://doi.org/10.1073/pnas.0611508104

Mottet, A., Bicksler, A., Lucantoni, D., De Rosa, F., Scherf, B., Scopel, E., López-Ridaura, S., Gemmil-Herren, B., Bezner Kerr, R., Sourisseau, J.-M., Petersen, P., Chotte, J.-L., Loconto, A., & Tittonell, P. (2020). Assessing transitions to sustainable agricultural and food systems: A Tool for Agroecology Performance Evaluation (TAPE). *Frontiers in Sustainable Food Systems*, *4*, Article 579154. https://www.frontiersin.org/article/10.3389/fsufs.2020.579154

Naderifar, M., Goli, H., & Ghaljaei, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education*, *14*(3), 1–6. https://doi.org/10.5812/sdme.67670

Natural Resource Conservation Service [NRCS]. (2021) *Natural Resource Conservation Service Regional Boundaries* [Figure]. https://www.nrcs.usda.gov/about/leadership

Paz Hidalgo, L. (2020). Highland agriculture in the hands of women. *Farming Matters, Agroecology and Feminism: Transforming our Economy and* Society, *36*(1), 28–30. https://www.cidse.org/wp-content/uploads/2020/10/FINAL_FarmingMatters_0120_webpdf.pdf

Pilgeram, R., Dentzman, K., Lewin, P., & Conley, K. (2020). How the USDA changed the way women farmers are counted in the Census of Agriculture. *Choices*, Quarter 1. http://www.choicesmagazine.org/choices-magazine/submitted-articles/how-the-usda-changed-the-way-women-farmers-are-counted-in-the-census-of-agriculture

Schmidt, C., Goetz, S. J., & Tian, Z. (2021). Female farmers in the United States: Research needs and policy questions. *Food Policy*, *101*, Article 102039. https://doi.org/10.1016/j.foodpol.2021.102039

Stake, R. E. (1995). *The art of case study research*. SAGE Publications.

Tittonell, P., Fernandez, M., El Mujtar, V. E., Preiss, P. V., Sarapura, S., Laborda, L., Mendonça, M. A., Alvarez, V. E., Fernandes, G. B., Petersen, P., & Cardoso, I. M. (2021). Emerging responses to the COVID-19 crisis from family farming and the agroecology movement in Latin America – A rediscovery of food, farmers and collective action. *Agricultural Systems*, *190*, Article 103098. https://doi.org/10.1016/j.agsy.2021.103098

Trauger, A. (2004). "Because they can do the work": Women farmers in sustainable agriculture in Pennsylvania, USA. *Gender, Place & Culture*, *11*(2), 289–307. https://doi.org/10.1080/0966369042000218491

Trauger, A., Sachs, C., Barbercheck, M., Brasier, K., & Kiernan, N. E. (2009). "Our market is our community": Women farmers and civic agriculture in Pennsylvania, USA. *Agriculture and Human Values*, *27*, 43–55. https://doi.org/10.1007/s10460-008-9190-5

Trevilla Espinal, D. L., Soto Pinto, M. L., Morales, H., & Estrada-Lugo, E. I. J. (2021). Feminist agroecology: Analyzing power relationships in food systems. *Agroecology and Sustainable Food Systems*, *45*(7), 1029–1049. https://doi.org/10.1080/21683565.2021.1888842

UNESCO. (n.d.). *Peri-urban landscapes; Water, food and environmental security*. https://en.unesco.org/events/peri-urban-landscapes-water-food-and-environmental-security#:~:text=Peri%2Durban%20areas%20are%20zones,into%20rural%20and%20industrial%20land

U.S. Department of Agriculture Food and Nutrition Service [USDA FNS] (2021). *Supplemental Nutrition Assistance Program*. https://www.fns.usda.gov/snap/supplemental-nutrition-assistance-program

USDA National Agricultural Statistics Service [USDA NASS] (2002). *2002 Census of Agriculture*. https://agcensus.library.cornell.edu/census_year/2002-census/

USDA NASS. (2007). *2007 Census of Agriculture*. https://agcensus.library.cornell.edu/census_year/2007-census/

USDA NASS. (2017). *2017 Census of Agriculture race/ethnicity/gender profile*. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Race,_Ethnicity_and_Gender_Profiles/cpd99000.pdf

USDA NASS. (2019). *Female producers: More than half of farms have at least one female producer*. https://www.nass.usda.gov/Publications/Highlights/2019/2017Census_Female_Producers.pdf

USDA NASS. (2020). *Farms and land in farms 2019 summary*. https://www.nass.usda.gov/Publications/Todays_Reports/reports/fnlo0220.pdf

Wells, B. L., & Gradwell, S. (2001) Gender and resource management: Community supported agriculture as caring-practice. *Agriculture and Human Values*, *18*(1), 107–119. https://doi.org/10.1023/A:1007686617087

Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, *29*, 503–515. https://doi.org/10.1051/agro/2009004

White, T., & King, S. (2019, April 11). *2017 Census of Agriculture data now available.* USDA. https://www.usda.gov/media/press-releases/2019/04/11/2017-census-agriculture-data-now-available

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., Vries, W. D., Sibanda, L. M., Murray, … & C. J. L. (2019). Food in the Anthropocene: The EAT–*Lancet* Commission on healthy diets from sustainable food systems. *Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

World Economic Forum. (2021, March 30). *The global gender gap report 2021.* https://www.weforum.org/reports/global-gender-gap-report-2021

Zaremba, H., Elias, M., Rietveld, A., & Bergamini, N. (2021). Toward a feminist agroecology. *Sustainability*, *13*(20), Article 11244. https://doi.org/10.3390/su132011244