Renewable Agriculture and Food Systems: 29(1); 65–82 doi:10.1017/S1742170512000348

Use of conservation practices by women farmers in the Northeastern United States

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Accepted 12 October 2012; First published online 28 November 2012 **Research Paper**

Abstract

Women are the fastest growing segment of farm operators in the United States, comprising approximately 14% of principal operators and 30% of all operators of the nation's 2.2 million farms. Although several studies have examined the adoption of conservation practices by farmers, no study of which we are aware has focused on the use of conservation practices among women farmers in the US. Therefore, in 2008, we conducted a survey of women farmers in the Northeast US to better understand their use of conservation practices, and how their use is affected by demographic and farm characteristics, and membership in agricultural organizations and networks. We examined the practices related to the type of agricultural organizations, including commodity producer organizations, general farm organizations, women's groups associated with general farm or commodity organizations, farm women's organizations, and sustainable/organic agriculture organizations. Over 85% of the 815 respondents belonged to at least one organization. The most common organizations reported were sustainable/organic agriculture organizations (53.5%) and general farm organizations (50.8%). About one-third of respondents belonged to commodity-based organizations. The states with organized women farmers' networks—Pennsylvania, Maine and Vermont—represented more than half of them. Members of women's and sustainable or organic agriculture organizations tended to be younger, have less farming experience, and to have received more formal agricultural education than did members of commodity-based, general farm and women's agricultural groups within general farm organizations. Our results indicate that organizational membership and participation provide critical networks that support and reinforce the use of conservation practices. Some practices were positively associated with one type of organization while negatively associated with others. For example, compost production/application, crop rotation, manure incorporation, and organic crop and livestock production are more likely among members of sustainable/organic agriculture organizations, but less likely among members of general farm organizations. The converse is true for integrated pest management (IPM) on crop farms. Specific conservation practices had unique sets of variables linked to their use, with farm products being the most frequent predictors. This research serves as a baseline to understand the array of conservation practices used by women farmers in the Northeast US, and some factors associated with their use. The results suggest the need for consideration of the applicability of existing adoption models for women farmers. As women tend to have diversified operations with multiple markets, educational and regulatory programs that attempt to reach women farmers may need to consider the specific types of farms they operate to best match practices to their situations and goals.

Key words: women farmers, conservation practices and structures, environmental sustainability, agricultural organizations, women's agricultural networks

Increasingly, consumers and policy makers are demanding that agriculture perform multiple functions in addition to food and fiber production, from natural resource conservation and environmental remediation (e.g., carbon sequestration and mitigation of greenhouse gases) to rural economic development,

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conservation of open space and viewscapes, and recreational opportunities[1–4]. This multifunctional expectation for agriculture creates challenges for farmers, who are now expected to balance environmental quality, productivity, profitability and social responsibility[5].

Public recognition of the impact of agriculture on the environment has resulted in the creation of numerous programs managed by federal, state and local agencies in the US to conserve natural resources on agricultural lands. These programs, such as the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Programs (CREP), Conservation Security Program (CSP) and Environmental Quality Incentives Program (EQIP), promote and support land management practices and structures that reduce soil erosion, protect ground and surface water, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. Participation in these programs requires that land managers implement those practices [best management practices (BMPs)] determined by agencies such as the Natural Resources Conservation Service (http://www.nrcs.usda.gov/) to reduce the environmental impact of agriculture and improve the condition of natural resources. Rates of adoption of these conservation practices and structures vary greatly due to differences in farm production systems, agroecological characteristics of the farm, farm business structure and farmer characteristics. Although there has been significant research examining the adoption of conservation practices[6], no study of which we are aware has focused on the use of conservation practices among women farmers in the US[7].

Women Farmers in the US

Women are the fastest growing segment of farm operator in the US[7]. In 1987, when the US Census of Agriculture first began identifying the gender of farm operators, women comprised 7% of all farmers. In 2002, the Census of Agriculture began counting farm operators in two capacities: as the principal operator and as one of multiple operators. Of the 3.3 million US farm and ranch operators on 2.2 million farms and ranches counted in the 2007 Census of Agriculture, women comprise 14% of the primary farm operators and 30% of all farm operators. These numbers of women principal operators of farms and ranches represent an increase of almost 30% between the 2002 and 2007 censuses.

Women-operated farms in the US differ from those operated primarily by men in several important ways[8]. Compared to all farms in the US, women-owned farms are small, diversified, and are more likely to be financially at-risk. Nearly 70% of women farm on less than 140 acres, approximately 80% report annual sales under $25,000, and they are more likely than male-operated farms to raise specialty crops or operate farms classified as 'other livestock farms,' which includes horse farms, or 'all other crops,' which includes hay farms[7]. By contrast, farms on which the primary operators are men are more likely to produce major commodities such grain, oilseeds and beef cattle.

Research over the past few decades has documented the sometimes hidden yet substantial roles women play on farms, including production, business management and decision-making, in addition to supportive and reproductive roles[8–14]. For example, Findeis et al.[15] found that 53% of farm women in their survey reported that they were major operators of their farms. Tasks in which women regularly participated include traditional (e.g., bookkeeping and running errands) as well as those related to farm production (e.g., taking care of animals, harvesting and fieldwork without machines). Women participated in important farm resource allocation decisions, including buying or selling land, buying major farm equipment, producing something new and trying a new production practice.

Concurrent with shifts in farm demographics has been the development of organizations that specifically target women farmers with education and assistance[16,17]. Traditional organizations that provide agricultural education, such as Cooperative Extension, have offered very limited production-focused education geared toward women farmers and their educational needs[10,12,17–20]. General US farm organizations, such as the Farm Bureau and the Grange, and commodity-based organizations historically have had women's affiliated groups, such as the Cowbelles, Porkettes and Wheathearts, that emphasize women's supportive or promotional role on farms[21]. More recently, organizations and networks have formed to specifically meet the needs of women farmers in the US, such as the Vermont, Maine and Pennsylvania Women's Agricultural Networks (WAgN; http://www.uvm.edu/~wagn/; http://www.umaine.edu/umext/wagn/; http://wagn.cas.psu.edu) and the Women, Food and Agriculture Network (WFAN; http://www.wfan.org/Women,_Food_and_Agriculture_Network_Home.html) in Iowa. These newer organizations typically utilize networks with a major goal of developing horizontal, peer-to-peer relationships for sharing experience-based information, social support and legitimacy as farmers[19,22–24]. These organizations offer educational opportunities that emphasize hands-on, interactive workshops, in which knowledge related to agricultural production, business management, and environmental and social sustainability is exchanged[17,23]. Women's agricultural networks and similar organizations developed in large part in response to the historical lack of information from conventional agricultural institutions, such as land-grant universities, about the use of alternative agricultural technologies, such as organic production and grazing-based livestock production[25–31].

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Conservation Practices

To better understand women farmers' use of conservation practices, multiple sets of individual, farm, household and economic characteristics, as well as the types and strength of social relationships of farmers should be considered[6,32]. There are few consistent predictors of adoption of conservation practices by US farmers[6,27,33–37], but that may not be necessarily true for women farmers.

Some characteristics that farmers use to evaluate technologies and practices include initial and long-term cost, labor requirements, the impact on production, profitability, and other farm enterprises, complexity of the practice, and the extent to which the technology or practice will confer an economic advantage or disadvantage[38,39]. Smit and Smithers[40] identified perceptions of the effectiveness of a practice for site-specific, biophysical farm conditions as an important barrier to adoption. Perceptions of the institutions that teach about or support the technology, and perceptions of the distribution of benefits and costs, can influence farmers' evaluation of the technology or practice[32].

Relatedly, characteristics of the farm itself, e.g., scale, profitability, markets, type of products, diversity of products, topography, labor availability and ownership structure, can influence the applicability of a particular practice or technology[6]. Size of farm and scale of production have generally been found to be positively associated with the adoption of conservation practices[6,41,42]. Farmers with more available resources, particularly capital, can invest in conservation practices and are more likely to realize tax benefits[43,44]. Landowners, compared to those who lease land, are more likely to adopt conservation practices because they have greater management flexibility and control[41,45]. Other farm characteristics that may influence adoption include the commodity produced, existing production practices, landscape characteristics and marketing strategies[32]. The diversity of enterprises within the farming operation may be positively related to adoption of conservation practices, as diverse-enterprise farms may be in a better position to experiment, and more types of practices are applicable. However, a farm that is over-diversified can be negatively associated with adoption of conservation practices because the farmer may not be able to sort through the multiple options that would apply to the different enterprises of the farm operation[46].

Individual actions regarding the natural environment take place within a context of social relationships and structural conditions[47–49]. Family and household characteristics, including number of people in the household, age of household members, off-farm work, location of decision-making authority and plans for the future of the farm, may influence adoption. For example, younger farmers are more likely to adopt conservation practices, presumably because they have longer planning horizons for the farm[6,50]. A farmer's individual resources, such as education and experience on the farm, also contribute to likelihood of adoption. The availability of labor—either hired or non-paid family labor—is positively associated with the adoption of conservation practices[41].

Farmers' individual beliefs and attitudes influence adoption of conservation practices, although inconsistencies in measurement make these relationships difficult to interpret[6]. In general, concern over environmental consequences of agricultural production influences the likelihood of adoption[40]. Farmers with an environmental orientation may weigh the costs and benefits of a particular practice or technology using different criteria, including environmental risks, risks to future generations' use of the land and resources, and risks to downstream users of the resources. Some farmers are willing to forego profit in favor of using farm practices that reflect environmental stewardship goals[34].

Farmers take into consideration the degree of congruence between the use of the technology and the goals that the farmer has for the farm. A related factor is the 'fit' between the goals of the technology and farmers' identities, such as producers, environmental stewards, entrepreneurs and innovators[51]. Further, a farmer's perceptions of how others in the community will judge the farm (and the farmer) using the new technology or practice affect a farmer's willingness to adopt a practice[35,49].

Organizations and Networks

In empirical studies, membership in formal organizations has shown limited but potentially positive impacts on adoption of conservation practices[32]. Formal organizations can be crucial information resources for learning about conservation practices[37]. Smit and Smithers[40] argue that membership in farmers' organizations indicates a progressive attitude or a willingness to seek new knowledge, which has been positively associated with adoption of conservation practices.

New types of organizations and networks have emerged to support farmers who either have personal characteristics (gender and ethnic background) or a farming type (organic, pasture-based, etc.) that have created barriers to accessing traditional educational resources. These new sources of information and support can significantly influence these farmers' practices, their levels of success and their identities as legitimate farmers[52,53]. Classical adoption/diffusion theory emphasizes the importance of social networks in two key stages of the process, awareness and evaluation[39,54]. Networks consisting of 'weak ties' (e.g., acquaintances), bring new information and ideas, such as BMPs, to an individual farmer[37]. Weak tie networks can raise awareness of conservation issues and support the identification of conservation problems on individual farms[40]. Networks consisting of 'strong ties' (e.g., family, close friends and advisors) play a significant

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role as farmers evaluate new information and technologies as to the fit to their farm and situation[6,32,55–58]. Discussions of the practice or technology with those most familiar with the individual farmer's circumstances can assist farmers as they think through its applicability and potential impacts on the farm and its management[38]. These discussions can build on the trust and knowledge that is embedded in the relationships between network participants[27,59]. Higher levels of trust within these relationships enhance the likelihood that farmers will discuss the new practices within their core network, which increases the propensity of adopting the practice[55].

In comparison with other innovations studied in classical adoption/diffusion research, networks become particularly crucial for adoption of conservation practices. In studies of non-conservation practices, the innovation is often a private good, with identifiable short- and long-term benefits for producers. In contrast, conservation practices result in more public than private goods, with short-term costs for the producer and uncertain long-term benefits[44,60]. Additionally, the environmental benefits of conservation practice adoption to an individual farmer depend partly on the decisions of other producers when they share a common-pool resource such as a watershed, exacerbating uncertainty[60]. Localized networks of producers can help ameliorate the collective action problem by creating a forum for sharing information about use of conservation practices and the establishment of new conservation-focused norms and expectations for action[48,53,61].

An important outcome of farmer participation in organizations and networks can be changes in self-identity, which can enhance conservation efforts. One approach of network-based conservation programs is to integrate new conceptualizations of farmers' roles as environmental stewards into their existing identities as business owners, entrepreneurs and innovators[53,62,63]. These new identities require thinking about activities in relationship to the environment in different ways, or redefining what are considered 'good' farming practices[51,63]. Networks provide forums for exploring potential new approaches without threatening existing identities. Networks also provide key locations for sharing of knowledge among experts and practitioners that can lead to more effective management practices[27,59,62,64].

The growth in numbers of women farmers, their role in farm management and decision-making, and their potential role in transferring conservation-related information, support the critical need to understand the impact of organizations on women farmers' use of conservation practices. Yet, we know relatively little about the conservation practices used by women farmers in the US. To what extent are women farmers practicing conservation techniques that enhance environmental quality? What are the characteristics of women farmers and their farms associated with using conservation practices? The ability to identify the characteristics of conservation practice adopters and non-adopters will affect the ability of educators and service providers to reach this audience with appropriate information and resources. Therefore, we conducted a survey to determine the use of specific conservation practices among women farmers in the Northeastern United States. We report these practices in relation to farm and farmer characteristics, including organizational and network membership. Based on the literature reviewed, we hypothesized that demographic characteristics, farm scale and participation in agricultural organizations will affect the use of conservation practices by women farmers.

Methods

To characterize women farmers in the Northeast US and examine our hypotheses about use of conservation practices, we conducted a survey of women farmers in the Northeast United States. For the purposes of this study, the Northeast is comprised of nine states: Pennsylvania, New York, Maine, New Hampshire, Connecticut, Massachusetts, Vermont, New Jersey and Rhode Island. We define women farmers as women who live on a farm and participate in farm labor and/or decision-making. As there was no publicly available list of women farmers in the region for the survey, a sampling frame was built by drawing from multiple sources, including membership directories, advertising materials and brochures, and web sites of farming organizations. Organizational sources represented multiple agricultural sectors, including traditional commodity producers (e.g., state-based labeling programs), sustainable or organic producers (e.g., Northeast Organic Farming Association, Pennsylvania Association for Sustainable Agriculture), and women's agricultural organizations (e.g., Vermont WAgN and Pennsylvania WAgN). Farms included in the sampling frame produced products prevalent in the region, including dairy, grains and oilseeds, horticulture, livestock and livestock products, fruit, greenhouse/nursery, specialty and value-added products (e.g., maple syrup, seeds, wine, etc.), or had other farm-based enterprises, e.g., agritourism such as bed and breakfasts, corn mazes, tours, etc. or educational programs.

Surveys were sent to a sample of 2000 farms drawn randomly from this sampling frame during the winter of 2007–2008. A modified Dillman method was used to administer the mail survey, including a five-contact mailing procedure (pre-notification, survey, reminder postcard, reminder with a survey and a final reminder letter) and a $1 incentive payment[65]. Labels and letters were addressed to the female name in the sample. If a female name was not available, the label was addressed to the 'Female Household Member' at the farm address. A total of 815 completed surveys were received, for a response rate of 40.7%.

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Table 1. Use of structures and practices applicable for crops ($n = 549$ respondents with row or horticultural crops).

	Number of respondents reporting as applicable	Percentage reporting presence/use in past 3 years[1]
Structure		
Permanent vegetation on slopes	426	81.0
Conservation buffers, permanent field borders, hedgerows, or windbreaks	478	79.9
Riparian buffers or filter strips (forest vegetative)	371	66.3
Grassed waterways or swales	369	61.0
Improved stream crossing	297	46.5
Fenced waterways	339	30.1
Contour buffer strips	357	30.0
Practice		
Crop rotation	499	90.4
Soil testing	530	84.2
Cover crops	496	82.3
Compost production or application	511	80.6
Mulching	483	79.1
Organic production	505	77.4
Conservation residue or tillage management	436	66.1
Manure incorporation after application	430	65.3
Hay or perennial forage planting	446	62.1
IPM	453	57.4
Contour or strip cropping	380	31.8

[1] Calculated as the percentage of those who reported having row or horticultural crops and who reported the structure or practice as applicable to their farms.

Key Variables

Use of conservation practices

To construct questions related to use of conservation practices, we used structural and management criteria developed by the USDA Natural Resources Conservation Service (http://www.nrcs.usda.gov/programs/eqip/). Decision or evaluative tools based on these conservation structures and management practices have been developed by the agency to determine eligibility of farmers for enrollment in various government support programs that promote agricultural production and environmental quality as compatible goals. We included a subset of these management practices and physical structures in the survey, and listed them separately for crop (Table 1) and for livestock production (Table 2). Respondents were asked to indicate if they had used the practice in the past 3 years (yes/no) or if the structure was currently present on their farm (yes/no), or if the practice or structure was not applicable to their farm. Tables 1 and 2 list each practice/structure and the percentage of respondents reporting its use, based on applicability for the type of farm.

Farm and farmer characteristics

We collected information on age, level of education, total household income in 2007, race/ethnicity, off-farm work, and the contribution of off-farm work to household income (Table 3). Survey questions related to farm characteristics include type of livestock and crops produced and scale of production (i.e., acres, number of livestock and gross farm income) (Table 4).

To determine the scale of the operation across different types of livestock, we calculated animal equivalent units (AEU) developed in local land use planning ordinances that fit the livestock types used in the survey and did not require differentiation by age of the animal. The animal equivalents used included: dairy cow, 1.33; beef cow, 1.0; horse, 2.0; hog, 0.4; sheep, 0.1; goat, 0.16; turkey, 0.0182; and chicken, 0.01. Aggregated results will appear over 100.00.

To assess the role of environmental considerations in farm planning, respondents indicated the importance (not, somewhat, moderately, or very important) of statements related to how they assess the success of their farms. Statements reflected goals related to environmental quality, profitability, building community relationships and quality of life (Table 5). Factor analysis produced three summative rating scales that reflect different measures of success in farming: (1) environmental sustainability (improving soil quality, improving environmental quality, and providing healthy food), (2) community relationships (being respected in my community, maintaining good relationships with other farmers, maintaining a high quality of life, and enjoying what I am doing), and (3) profitability (increasing profitability,

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Table 2. Use of structures and practices applicable for livestock ($n = 503$ respondents with livestock).

	Number of respondents reporting as applicable	Percentage reporting presence/use in past 3 years[1]
Structure		
Permanent vegetation on slopes	442	77.6
Grassed waterways or swales	382	54.7
Riparian buffers or filter strips (forest or vegetative)	389	53.5
Composting facility	445	45.4
Improved animal trails or walkways	393	42.5
Fenced waterways	374	41.2
Barnyard run-off control	394	38.8
Contour buffer strips	365	24.1
Protected solid or liquid waste storage facility	378	17.7
Stream side watering systems	352	15.6
Practice		
Management intensive, rotational, or prescribed grazing	439	71.3
Pasture or hay planting	460	63.9
Following a nutrient management plan	429	56.9
Organic livestock production	448	51.1
Manure transfer	395	50.4
IPM	403	31.5

[1] Calculated as the percentage of those who report having livestock and who report the structure or practice as applicable to their farms.

satisfying customers, and increasing production yields). As summarized in Table 5, reliability of these scales is satisfactory; the Cronbach's alpha values are 0.62 for the three-item scale related to environmental quality, 0.60 for the four-item scale related community relationships, and 0.62 for the three-item scale related to profitability.

Participation in organizations

Participation in farm-related organizations was measured with multiple questions. First, respondents were asked to indicate formal membership (registered or dues-paying), either currently or within the past 3 years, in five distinct types of organizations. The options included commodity producer organizations (e.g., American Dairy Association and Fruit and Vegetable Growers Association), general farm organizations (e.g., Farm Bureau and Grange), women's groups associated with general farm or commodity organizations (e.g., Farm Bureau Women), farm women's organizations (e.g., Vermont Women's Agriculture Network and Women Involved in Farm Economics), and sustainable/organic agriculture organizations (e.g., Pennsylvania Association for Sustainable Agriculture, Maine Organic Farmers and Growers Association, and Northeast Organic Farming Association). These organizations differ significantly in their approach to information sharing (e.g., expert-to-learner versus peer-to-peer learning), topics they address, and willingness to explore alternative approaches to agriculture[66]. These differences raise the possibility that the structure and orientation of organizations may affect the type and scope of information about conservation practices that is conveyed to farmers.

Higher levels of participation may increase exposure to ideas shared within the organization or network and the level of trust and degree of embeddedness within the organizations[60]. Respondents were asked to indicate the frequency with which they participate in various activities of these organizations, such as visiting websites, reading publications, communicating with staff and other members, attending educational events and serving in leadership positions. The response categories included not applicable, never, sometimes, frequently and always. A scale was then created that summed respondents' answers to these activities to represent level of organizational participation. Reliability of the scale is satisfactory, with a Cronbach's alpha of 0.83[67].

The third measure of participation accounts for differences in the type of organization by measuring reasons for joining the organization. Survey respondents were asked to indicate the importance (not, somewhat, moderately or very important) of 14 potential reasons for joining farm organizations. Factor analysis was conducted on these items, and resulted in the development of three summative rating scales that reflect distinct types of reasons for joining: (1) to learn about production, (2) to develop business and personal networks, and (3) to advocate for farmers, women farmers or the food system. Reliability of these scales is satisfactory[67]; Cronbach's alpha values are 0.88 for the three-item scale related to

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Table 3. Selected demographic characteristics of survey respondents.

Respondent characteristics	Percentage of respondents
Age	
Under 25 years	0.8
25–34 years	9.7
35–44 years	17.0
45–54 years	31.9
55–64 years	28.2
65–74 years	10.0
75 years and over	2.4
Formal education related to agriculture	18.7
Level of education	
Less than high school grade	2.1
High school grade	11.9
Vocational or technical school	6.6
Some college	22.5
4-year degree	27.4
Post-graduate education	29.5
Off-farm paid job	51.1
Percentage of household income from wage/salary job	
None	26.1
1–25%	13.9
26–50%	10.3
51–75%	10.6
76–100%	39.2
Household income from all sources in 2006	
Less than $10,000	4.9
$10,000–$29,999	17.1
$30,000–$49,999	21.5
$50,000–$74,999	24.1
$75,000–$99,999	13.4
$100,000–$249,999	15.5
$250,000 or more	3.7
State	
Pennsylvania	19.6
Maine	18.9
Vermont	17.5
New York	16.0
Massachusetts	12.9
Connecticut	4.4
New Jersey	4.2
New Hampshire	3.8
Rhode Island	2.7

learning about production, 0.87 for the five-item scale related to developing networks and 0.89 for the four-item scale related to advocacy.

Statistical analyses

Survey data were analyzed using the statistical software package SPSS version 16.0[68]. Statistical analyses presented include descriptive statistics (i.e., percentages, means, medians, standard deviations and ranges). For the purposes of the multivariate analyses of farm characteristics, farms were classified into a series of bimodal types reflecting key farm characteristics and scale indicators, such as farms growing agronomic crops (corn, soybeans or grains; $n = 260$), farms growing horticultural crops (small fruits, tree fruits, vegetables, tobacco or nursery; $n = 487$), and those producing any livestock ($n = 503$). Scale is denoted by both acreage and number of livestock using quartiles as cut points. Large farms are those with more than 61 AEU or more than 177.5 acres; small farms are those with less than 4.5 AEU or less than 20 acres. As the structures and management practices are binary variables, bivariate and multivariate analyses include measures of association (Goodman and Kruskal's tau), non-parametric correlations (Spearman's rho) and logistic regression.

To address hypotheses related to the use of conservation practices by women farmers, we used logistic regression models for each management practice in crop production and livestock production systems. The model chi-square statistics indicate the degree of improvement of the specified model over a baseline model; larger chi-square values indicate greater improvement[69].

Results

Demographic profile of the women farmers

The average age of respondents to our survey was 51.2 years. The distribution across age categories reflects a mix of ages, with about one-quarter (27.5%) under 44 years of age, about one-third (31.9%) between 45 and 54 years of age, about one-quarter (28.2%) between 55 and 64 years of age, and 12.4% over the age of 65 (Table 3). Nearly all (89.0%) respondents were Caucasian. A small percentage (2.6%) indicated they are members of the Anabaptist community. One-quarter (28.7%) of respondents indicated that they grew up on a farm or ranch. Respondents were relatively highly educated, with more than half (56.9%) holding a college or post-graduate degree. Fewer than one-quarter (18.7%) received formal education in agriculture (Table 3).

Household income varied within the sample (Table 3). About 5% indicated that total household income from all sources was below $10,000. Over one-third (38.6%) reported household income between $10,000 and $50,000. A similar percentage (37.5%) reported income between $50,000 and $100,000. About one-fifth (19.2%) of the sample reported income above $100,000. About one-half (51.1%) of the respondents worked off the farm in a salary or wage job. Approximately half of the respondents (49.8%) indicated that the source of half or more of their household income was an off-farm job. About one-quarter of respondents (26.1%) reported that they receive no household income from an off-farm job.

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Table 4. Selected farm characteristics of survey respondents ($n = 815$).

Farm characteristics	Percentage of respondents
Producing row or horticultural crops	73.9
Vegetables	52.6
Small fruits and brambles	30.7
Pasture	27.6
Horticulture plants/nursery/flowers	25.0
Alfalfa/hay	24.4
Tree fruits/nuts	18.7
Corn/soybeans	16.6
Producing livestock	66.4
Chickens (layers)	37.9
Horses	26.7
Beef cattle	21.6
Hogs, pigs	21.2
Other poultry	19.4
Sheep, lambs	19.3
Dairy cattle	19.1
Goats, kids	18.7
Chickens (broilers)	18.5
Gross farm sales	
Less than $10,000	36.4
$10,000–$49,999	26.9
$50,000–$99,999	12.0
$100,000–$249,999	13.3
$250,000 and over	11.3
Total acres (rented and owned)	
1–9 acres	12.1
10–29 acres	19.3
30–49 acres	10.5
50–99 acres	15.4
100–199 acres	19.7
200–499 acres	16.7
500 acres or more	6.4
Membership in organizations	
Sustainable/organic agriculture groups (e.g., Pennsylvania Association for Sustainable Agriculture, Maine Organic Farmers and Growers Association)	53.5
General farm organization (e.g., Farm Bureau or Grange)	50.8
Commodity producer associations (e.g., American Dairy Association or Fruit and Vegetable Growers Association)	36.8
Farm women's organization (e.g., Vermont Women's Agriculture Network or Women Involved in Farm Economics)	20.6
Women's groups associated with general farm or commodity organizations (e.g., Farm Bureau Women)	10.5

Farm characteristics

The respondents' farms were generally small. About one-third (36.4%) reported gross farm sales of less than $10,000, with an additional quarter (26.9%) between $10,000 and $50,000 (Table 4). Nearly three-quarters of the sample (73.9%) produced row or horticultural crops, while two-thirds (66.4%) produced livestock (Table 4). The primary crops grown included vegetables (52.6%), small fruits and brambles (30.7%), pasture (27.6%), horticulture plants, nursery or flowers (25.0%), and alfalfa/hay (24.4%). The primary livestock on the farms in the sample are laying hens (36.7%), horses (26.7%), beef cattle (21.6%) and hogs (21.2%) (Table 4).

A majority of the sample (71.7%) sold their products through direct retail outlets or directly to consumers. Nearly three-quarters (74.6%) of the sample used at least one strategy to add value to their farm products, such as

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Table 5. Descriptive statistics for interval level variables.

	Mean	Standard deviation	Range	Cronbach's alpha
Participation level scale (7 items)	14.5	4.2	2.0–28.0	0.83
Scales of reasons for joining organizations				
To learn about production (3 items)	9.4	2.5	3.0–12.0	0.88
To network (5 items)	13.4	4.1	3.0–20.0	0.87
To advocate (4 items)	11.8	3.5	1.0–16.0	0.89
Scales of farm goals				
Environmental quality (3 items)	13.7	1.8	4.0–15.0	0.62
Building relationships (4 items)	18.2	2.1	8.0–20.0	0.60
Increasing profitability (3 items)	10.6	2.3	3.0–15.0	0.54
Age	51.2	12.0	15–85	NA

organic and specialty production, on-farm processing or agritourism.

The scales of farm goals were reported as the high mean values for three scales measuring importance of building relationships (18.2 with a maximum value of 20), environmental quality (13.7 with a maximum value of 15), and increasing profitability (10.6 with a maximum value of 15) (Table 5).

Organizational participation

Most respondents (86.5%) reported membership in at least one organization; more than half (55.8%) belonged to two or more organizations (Tables 4 and 5). The most common organizations among respondents were sustainable/organic agriculture organizations (53.5%) and general farm organizations (50.8%). About one-third of respondents (36.8%) belonged to commodity-based organizations. Respondents were less likely to be a member of women's farm-related organizations, with 20.6% reporting membership in women's agriculture organizations. The states with organized women farmers' networks—Pennsylvania, Maine and Vermont—represented more than half of those (56.0%) (Table 3). Because of the small percentage of respondents (10.5%) who were members of women's groups within general farm organizations, this category was deleted from further analyses. The scale of organizational participation was reported as the high mean value (14.5 with a maximum of 28) (Table 5).

Organizational participation and conservation practices

Level of participation in organizations was positively but weakly associated with use of conservation practices. Higher levels of participation were related to an increase in the odds of using compost production/application (9%), conservation residue and tillage management (8%), crop rotation (11%), organic production (8%), integrated pest management (IPM) for livestock (7%) and organic livestock production (8%).

Reasons for joining an organization tended to be weakly associated with use of conservation practices, both positively and negatively. Women farmers who reported joining organizations to improve productivity and profitability were more likely to use soil testing (18%) and IPM for both crops (13%) and livestock (17%), and less likely to use organic livestock production methods (14%). Those who reported networking as a main benefit from organizational membership also reported a lower likelihood of using IPM for livestock (12%) and rotational or other management intensive grazing systems (10%), and greater likelihood of using compost production/application (11%) and manure incorporation (14%). Women farmers who reported advocacy for farms, women farmers and local foods as a major reason for organizational membership were less likely to use soil testing (14%) and manure incorporation (14%), and more likely to use organic livestock production (14%), rotational or other management intensive grazing systems (20%) and nutrient management planning (15%).

Use of conservation structures and management practices

Of the structures and practices listed by respondents for crop production systems for whom the structure or practice is applicable, all but three structures (improved stream crossings, fenced waterways and contour buffer strips) and one management practice (contour or strip cropping) were used by more than half of respondents within the past 3 years (Tables 1 and 2). Large percentages of respondents reported using conservation practices, such as conservation buffers (79.9%), riparian buffers (66.3%), crop rotation (90.4%), cover crops (82.3%) and conservation tillage (66.1%). Nearly three-quarters (77.4%) report using organic crop production practices.

Significant percentages of respondents with livestock reported use of conservation practices (Tables 1 and 2). For example, respondents reported using structures that are intended to protect water quality, such as improved animal trails (42.5%), fenced waterways (41.2%) and barnyard run-off control methods (38.8%). Similarly,

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Table 6. Logistic regression models predicting likelihood of use of conservation practices related to crops.[1,2]

	Compost production or application (*n* = 393)	Conservation residue and tillage management (*n* = 349)	Contour or strip cropping (*n* = 303)	Cover crops (*n* = 384)	Crop rotation (*n* = 389)	Hay/ perennial forage planting (*n* = 354)
Producing agronomic crops	0.89	1.42	**4.25*****	**2.89****	**2.23+**	**4.42*****
Producing horticultural crops	**2.91***	1.45	0.74	**2.21+**	**4.45****	0.69
Producing livestock	**2.55***	0.76	**0.27****	**0.43***	1.33	**2.88****
Farm with >61 AEU[3]	0.67	0.84	0.84	**0.33***	1.04	1.37
Farm with <4.5 AEU	1.99	0.90	1.93	**6.52****	1.10	0.89
Farm with >177.5 acres	0.93	0.80	0.87	0.78	1.31	1.31
Farm with <20 acres	**5.65****	1.41	1.31	0.67	2.09	**0.39***
Gross farm income	0.88	**1.25+**	1.06	**1.59****	1.26	1.22
Age	1.01	1.00	1.02	0.99	1.01	1.01
Education	1.05	1.02	0.93	0.98	0.98	**0.79***
Formal agriculture education	1.02	1.36	1.64	1.19	0.98	**2.54***
Work off-farm	1.04	0.68	1.07	0.85	1.08	**1.70+**
Goals—environmental quality	**1.29***	1.17	1.12	**1.26***	**1.31***	1.04
Goals—building relationships	**0.87+**	0.95	0.93	1.13	1.10	0.99
Goals—increasing profitability	1.03	0.99	**1.13+**	1.02	1.00	1.01
Commodity producer organizations	1.35	0.83	1.11	0.58	1.26	0.88
General farm organizations	**0.57+**	0.87	0.88	0.69	**0.29****	0.69
Women's agricultural organizations	0.71	1.30	0.69	0.82	0.69	1.11
Sustainable/organic agricultural organizations	**2.37***	1.15	1.38	**2.41***	**2.56***	1.06
Level of organization participation	**1.09+**	**1.08***	1.00	1.06	**1.11+**	1.01
Join to learn about production	0.98	0.98	1.04	1.08	1.13	0.91
Join to network	**1.11+**	1.06	1.05	0.99	1.03	1.05
Join to advocate	1.00	0.98	0.96	0.94	0.87	1.03
Model chi-square	100.48***	33.77+	43.67**	87.14***	54.63***	124.41***
Log Likelihood	302.08	420.40	336.27	294.94	211.64	342.15
Nagelkerke *R*-square	0.35	0.13	0.19	0.32	0.26	0.41

	IPM (*n* = 357)	Manure incorporation after application (*n* = 327)	Mulching (*n* = 377)	Organic production (*n* = 390)	Soil testing (*n* = 409)
Producing agronomic crops	0.73	1.32	0.78	1.13	**2.77****
Producing horticultural crops	**4.29*****	**2.32***	**9.90*****	1.57	0.88
Producing livestock	0.57	**3.37****	1.43	1.54	**0.28****
Farm with >61 AEU	**0.26****	0.96	0.82	1.18	1.28
Farm with <4.5 AEU	1.58	2.16	2.04	**2.90+**	1.06
Farm with >177.5 acres	0.90	0.97	0.56	0.94	1.00
Farm with <20 acres	0.96	1.19	**3.05***	**9.41*****	0.90
Gross farm income	**1.84*****	1.00	1.00	**0.77+**	**1.34+**
Age	1.02	1.01	1.02	1.01	1.00
Education	0.88	0.88	1.00	1.08	**1.31***
Formal agriculture education	1.52	**2.10***	0.92	0.95	0.60
Work off-farm	1.25	1.45	0.92	0.85	**0.49***
Goals—environmental quality	1.07	1.13	**1.26***	**1.54*****	1.19
Goals—building relationships	0.94	1.04	0.89	0.99	1.02
Goals—increasing profitability	1.03	1.05	0.91	0.96	1.07
Commodity producer organizations	**1.65+**	1.38	1.38	0.77	1.36

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

Table 6. (*Cont.*)

	IPM (*n* = 357)	Manure incorporation after application (*n* = 327)	Mulching (*n* = 377)	Organic production (*n* = 390)	Soil testing (*n* = 409)
General farm organizations	1.36	**0.57+**	1.08	**0.43***	1.03
Women's agricultural organizations	1.23	**2.20***	2.26	0.89	1.15
Sustainable/organic agricultural organizations	**0.54+**	**2.09***	1.16	**3.61*****	**2.19***
Level of organization participation	0.95	0.98	1.07	**1.08+**	1.06
Join to learn about production	**1.13+**	1.02	1.07	1.12	**1.18***
Join to network	0.93	**1.14***	0.99	0.92	1.00
Join to advocate	1.03	**0.88***	1.00	1.01	**0.86***
Model chi-square	107.70***	74.17***	111.32***	145.79***	70.48***
Log likelihood	378.06	348.70	275.75	280.33	284.36
Nagelkerke *R*-square	0.35	0.28	0.39	0.47	0.264

[1] Coefficients reported are estimated odds ratios [Exp(β)]; values above 1.00 indicate positive association with use of practice/structure.
[2] Significant values are indicated by + $P < 0.10$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
[3] Animal equivalence units (AEU): dairy cow = 1.33, beef cow = 1.0, horse = 2.0, hog = 0.4, sheep = 0.1, goat = 0.16, turkey = 0.0182, and chicken = 0.01.

respondents indicated use of practices related to nutrient management, with more than half (56.9%) following a nutrient management plan and half (50.4%) using manure transfer practices. Nearly three-quarters (71.3%) reported using rotational or other managed grazing, and about half (51.1%) reported using organic livestock production methods.

Most models for the use of crop conservation practices were statistically significant, with the exception of the model for conservation tillage ($P < 0.10$) (Table 6). Pseudo-R^2 measures (Nagelkerke R^2) provide general guidance as to model fit, although strictly speaking, cannot be interpreted as the percentage of variance explained. For crop-related measures, the overall model fit for each practice varied, from a low of 0.13 for conservation tillage to a high of 0.47 for organic production. All chi-square statistics for the models of the livestock conservation practices are significant. For livestock-related measures, pseudo-R^2 measures (Nagelkerke R^2) indicate the overall model fit for each practice varied, from a low of 0.16 for IPM and manure transfer to a high of 0.32 for organic livestock production (Table 7). In general, the specified models are relatively weak predictors of adoption of conservation practices related to livestock production.

Exponentiated logistic regression coefficient [Exp(B)] values indicate the change in odds of the dependent variable associated with a change in value of the independent variable (Tables 6 and 7)[69]. Exact interpretation depends on the level of measurement of the independent variables. For example, producing horticultural crops (binary) has an exponentiated coefficient of 2.91 for compost production/application. Women farmers who produce horticultural crops have a 191% increase in the odds [(2.91–1)*100] of producing/applying compost on their farms. Similarly, producing livestock (155%), having small acreage (465%) and being a member of a sustainable/organic agricultural organization (137%) increases the odds of compost production/application.

Continuous variables, such as the scales related to goals and organizational participation, can be interpreted such that a unit change in the independent variable is associated with a change in odds of adopting the practice. For example, a one-point increase in the scale of goals related to environmental quality results in an increase in the odds of using compost production/application by 29%. Similarly, a one-point increase in level of organizational participation relates to an increase in the odds of using compost production/application by 9%; a one-point increase in the scale of joining agricultural organizations to network relates to an increase in the odds of using compost production/application by 11%. Variables that decrease the odds of using compost production/application include farm goals related to building community relationships (13%) and membership in general farm organizations (43%). This constellation of variables indicates that use of compost production/application is most likely to occur on smaller, diversified livestock/vegetable farms, in which the farmer is interested in improving environmental quality and participates in sustainable/organic agricultural organizations, but not general farm organizations.

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

Table 7. Logistic regression models predicting likelihood of use of conservation practices related to livestock.[1,2]

	IPM ($n=306$)	Management intensive, rotational, or prescribed grazing ($n=329$)	Manure transfer ($n=295$)	Following a nutrient management plan ($n=325$)	Organic livestock production ($n=332$)	Pasture or hay planting ($n=343$)
Producing agronomic crops	1.08	1.08	1.05	1.03	0.94	**3.94*****
Producing horticultural crops	1.64	0.75	**1.94***	**1.67+**	0.99	0.65
Farm with >61 AEU	1.05	1.33	**2.44***	**4.32*****	1.62	1.92
Farm with <4.5 AEU	0.82	**0.37****	0.59	0.74	1.05	0.65
Farm with >177.5 acres	0.65	1.44	0.89	0.84	1.19	0.81
Farm with <20 acres	1.49	1.50	1.28	1.33	0.76	0.99
Gross farm income	**1.24+**	0.94	0.90	1.11	0.89	1.14
Age	1.02	**0.96****	1.01	1.02	1.01	1.00
Education	1.01	1.07	0.99	1.02	**0.75****	0.94
Formal agriculture education	1.43	1.07	0.95	1.18	0.88	**1.90+**
Work off-farm	0.98	1.21	0.93	1.18	1.39	1.54
Goals—environmental quality	1.01	1.10	0.99	1.05	1.17	1.03
Goals—building relationships	1.01	0.96	0.99	0.97	1.07	0.91
Goals—increasing profitability	0.97	0.95	**1.14***	1.07	1.00	1.03
Commodity producer organizations	**1.87***	1.20	**1.85***	**1.76***	**0.49***	0.97
General farm organizations	1.05	0.76	1.17	1.04	0.72	1.05
Women's agricultural organizations	**2.00***	1.10	1.28	0.88	0.90	0.67
Sustainable/organic agricultural organizations	0.65	**2.01***	1.62	0.78	**5.10***	1.22
Level of organic participation	**1.07+**	1.05	0.98	0.99	**1.08***	0.98
Join to learn about production	**1.17***	1.09	1.11	1.01	**0.86***	1.02
Join to network	**0.88***	**0.90+**	0.99	0.99	0.95	0.97
Join to advocate	1.05	**1.20****	1.07	**1.15***	**1.14***	1.05
Model chi-square	36.19*	63.63***	36.84*	48.48**	90.16***	66.623***
Log likelihood	351.96	335.392	372.118	394.03	370.043	377.82
Nagelkerke *R*-square	0.16	0.25	0.16	0.19	0.32	0.24

[1] Coefficients reported are estimated odds ratios [Exp(β)]; values above 1.00 indicate positive association with use of practice/structure.
[2] Significant values are indicated by $+P<0.10$, $*P<0.05$, $**P<0.01$ and $***P<0.001$.
[3] Animal equivalence units (AEU): dairy cow = 1.33, beef cow = 1.0, horse = 2.0, hog = 0.4, sheep = 0.1, goat = 0.16, turkey = 0.0182, and chicken = 0.01.

Farms producing agronomic crops (i.e., corn, soybeans and grains) are more likely to use contour/strip cropping (increased odds by 325%), cover crops (189%), crop rotation (123%), hay/perennial forage planting (342%), soil testing (177%) and pasture/hay planting (294%). Farms growing horticultural crops (i.e., small fruits, tree fruits, vegetables, tobacco or nursery) have higher odds of using compost production/application (191%), cover crops (121%), crop rotation (345%), IPM for crops (329%), manure incorporation (132%), mulching (890%), manure transfer (94%) and follow a nutrient management plan (67%). Farms with any livestock have higher odds of adopting compost production/application (155%), hay/perennial forage planting (188%) and manure incorporation (237%); these farms have lower odds of contour/strip cropping (73%), cover crops (57%) and soil testing (72%).

Discussion

Demographic profile of the women farmers

Overall, our findings provide detailed information about women farmers in the Northeast US. Respondents to our survey differed from US averages for several demographic

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

characteristics, e.g., they were younger and derived a lower percentage of their household income from an off-farm source. The average age of respondents to our survey was 51.2 years, younger than the average age of all US farmers (54.9 years), all US principal operators (57.1 years), and average age of all female principal operators (54 years)[7]. We hypothesized that farmer age would be negatively associated with adoption of conservation practices. We found that age was not generally associated with the use of conservation practices by women farmers in our survey. Age of respondent was only associated with a small decrease (4%) in the odds of using rotational or other management intensive grazing in our sample. This is in contrast to Soule et al.[50] and Prokopy et al.[6], who found that age can have a negative effect on the adoption of conservation practices due to relatively shorter planning horizons.

About one-half (51.1%) of the respondents worked off the farm in a salary or wage job. According to the 2007 Census of Agriculture[7], 80.5% of women farm operators earn less than 25% of total household income from the farm, and approximately 87% derive more than half of total farm income from an off-farm source. In our sample, a much lower percentage, approximately half of the respondents (49.8%), indicated that the source of half or more of their household income is an off-farm job.

The majority of the respondents received an education beyond high school, and we hypothesized that level of education would be positively related to use of conservation practices. However, education level had a varied association with use of conservation practices. For example, respondents with more education had a lower likelihood of planting hay/perennial forages (21%) and organic livestock production (25%), but higher likelihood of soil testing (31%). This result is in contrast to Caswell et al.[41] and Prokopy et al.[6], who found that years of education and farming experience were positively related to use of conservation practices. Those authors hypothesized that more educated and experienced farmers are exposed to more ideas and have more experience in making decisions. A minority percentage of respondents in our survey received a formal agricultural education, but having a formal agricultural education increased the odds of planting hay/perennial forages (154%), manure incorporation (110%) and planting pasture or hay (90%). These practices are also associated with livestock production (Table 6), and may reflect practices common to dairy and other livestock farms in the Northeast US.

We hypothesized that farmer orientation relative to the environment would be positively related to adoption of conservation practices. In our sample, farm goals (improving environmental quality, building relationships and increasing profitability) showed some relationships with several conservation practices. Higher values on the scale related to improving environmental quality as a measure of farm success were related to increased likelihood of using compost production/application (29%), cover crops (26%), crop rotation (31%), mulching (26%) and organic production (54%). This provides limited support for research that has found an association between environmental orientation and use of conservation practices[6,34].

Farm characteristics

Women farmers in our sample reflect national trends in the US related to scale of farm (small), type of farm (diversified, predominantly horticulture and livestock) and use of diversified marketing strategies (a high proportion of direct marketing and value-added strategies). In our survey, the respondents' farms were generally small. The mean total number of acres operated (owned and rented) was 150 acres. However, 41.9% of respondents operated less than 50 acres. Over 60% reported gross farm sales of less than $50,000. These numbers are consistent with the 2007 US Census of Agriculture[7], which reports that nearly 80% of women-operated farms had annual sales under $25,000. A key difference between our sample and national data relates to the balance of farm and non-farm household income. Our sample included more women farmers for whom the farm provides significant household income.

We hypothesized that farm resources, such as type, income and scale of production, would be positively related to the use of conservation practices. Farm type, in particular, conditioned which conservation practices 'fit' the farm. Farm product (agronomic crop, horticultural crop and livestock) was the most consistent and strongest predictor of use of the various types of conservation practices analyzed.

Farm scale is a routine predictor; however, we speculate the causal mechanism may not be additional resources available to farmers of larger scale farms. As women tend to operate small, diversified farms, scale in terms of acreage or number of livestock may not be an accurate indicator of access to capital or other resources. Instead, scale of production might be an indicator, along with main farm product, of a type of farm. Scale in terms of gross farm income may be a better indicator of resources, and it was associated with some conservation practices (IPM, conservation tillage, cover crops and soil testing) most often associated with larger, conventional agronomic crop farms. These findings also suggest a need for development of a typology of farm 'types' that include the types of diversified farms owned and operated by women farmers. Educational and technical assistance related to conservation practices could be prioritized and targeted to match these particular types of farms.

The relationships between farm scale and conservation practices varied. Larger livestock farms (the top quarter of our sample in number of AEU) had a lower likelihood of using cover crops (67%) and IPM methods for crops (74%); they had a higher likelihood of using manure transfer (144%) and following a nutrient management

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

plan (332%). The latter two practices are linked to regulatory requirements only applicable to large-scale livestock farms.

Farms in the bottom quarter in number of AEU had a greater likelihood of using cover crops (552%) and organic crop production (190%), but a lower likelihood of rotational or other managed grazing (63%). In rotational or other management intensive grazing systems, livestock are regularly and systematically moved to fresh paddocks to maximize the quality and quantity of forage growth[70]. Even though managed grazing has demonstrated economic and environmental benefits, continuous grazing is the most common grazing system in the US[71]. Farmers who have low numbers of animals may choose to use continuous grazing because, compared with intensively managed grazing systems, capital investment is lower because of lower fencing and watering facilities requirements. Time commitment can be lower and management decisions can be simpler in continuous grazing systems because intensively managed grazing systems require careful monitoring of livestock and the pasture resource. The inverse association between cover crop use, which is used mainly in annual cropping systems[72], and management intensive grazing may reflect a focus of resources and management effort on crop production with lower investment in animal production.

Large scale in terms of acreage (>177.5 acres) was not associated with use of conservation practices. Small acreage farms (<20 acres) had a higher likelihood of using compost production/application (465%), mulching (205%) and organic crop production (841%). Although size of farm has generally been found to be positively associated with the use of conservation practices[6,41,42], our findings suggest that the relationship between size is likely mediated by production practices, and type and mix of products on the farm. Of the 20,437 organic farms in the US, over 45% produce on less than 9 acres, and approximately 70% produce on less than 49 acres[7]. As certified organic producers in the US are prohibited from using synthetic fertility or weed control inputs, they must rely on substances such as composts, and green and animal manures to manage soil fertility. Cultural practices, such as tillage and mulching with cover crop or crop residues can be used to suppress weeds. In 2007, 51.3 and 65% of US organic farms reported using organic mulch or compost, or animal or green manures, respectively[7]. Our results agree with the use of these conservation practices on small acreage organic farms.

Our final measure of scale, gross farm income, has several significant coefficients. An increase in category of gross farm income is associated with an increased likelihood of using conservation residue and tillage management (25%), cover crops (59%), IPM for crops (84%) and for livestock (24%), and soil testing (34%); it is associated with a decreased likelihood of organic crop production methods (23%). These results suggest that larger scale is linked to a suite of practices used largely on traditional dairy/agronomic crop farms. These findings suggest some support for the general finding in the literature that increased capital offers resources with which farmers can make investments associated with conservation practices[6,43].

The size of farms may also relate to their profitability. Data from respondents of our survey revealed a strong association of organic production and farms of less than 20 acres (Table 6). In the US, approximately 65% of all farms are small (median size 69 acres), and of those, 73% of fall into a sales class of less than $10,000, and about 30% fall into a sales class of $10,000–49,000[73]. Profitability measures are strongly associated with farm size. The average operating profit margin and average rates of return on assets and equity are negative for small farms, but positive for large-scale farms. Households operating small farms typically receive substantial off-farm income. In 2008, more that half (50.7%) of organic farms earned less than 49% of their net household income from farm sales, and most of those (45% of all organic farms) earned less than 25% of their net household income from farm sales[7].

Consistent with census results on women farmers[7], farms in our sample are diverse and emphasize non-commodity farm products. However, our sample differs significantly from the national averages for organic farming and direct marketing of farm products. In 2007, organic farms comprised only 9.3% of all US farms, with women comprising 22% of principal operators of organic farms. In contrast, nearly 50% of the women farmers in our sample reported using organic production methods. Also in marked contrast to US averages, a majority of the respondents to our survey (71.7%) sold their products through direct retail outlets or directly to consumers. One of the differences between conventional and organic food marketing is the use of direct markets—an estimated 1.6% of US fresh produce sales are through direct sales, while approximately 7% of US organic food sales occur through marketing channels other than retail stores[7]. Nearly three-quarters (74.6%) of our sample used at least one strategy to add value to their farm products, such as organic and specialty production, on-farm processing or agritourism.

The generally small size of women's farms in our sample, and their location in the Northeast US, may contribute to the observed differences from the national data for direct marketing and other value-added strategies, such as organic production. In 2007, there were 136,817 farms in the US, or about 6% of the total number, that sold agricultural products directly. Nearly all US farms that engaged in direct sales were small farms, which accounted for 93.3% of all farms engaged in direct sales and generated 56.7% of the total value of agricultural products sold directly to consumers. The majority of farms in our sample can be considered small, with only 3.7% reporting household income from all sources of $250,000 or more. California has the most direct sales of agricultural products, accounting for 13.4% of total direct

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

sales followed by New York and Pennsylvania, with 6.4 and 6.3% of total direct sales, respectively. These results raise questions for further research as to why these women are more likely to engage in organic farming and direct marketing or other value-added practices.

One could speculate that organic production and direct marketing may be means for women farmers to increase their profitability. On average, organic farms in the US have an average operating profit nearly double that for all farms, $45,697 for organic versus $25,448 for all farms[7]. However, we observed a negative relationship between gross farm income and organic crop production. The negative relationship between gross income and organic production may have differed if we had measured net income, because production expenses are higher on organic farms than on conventional farms. On average, US certified and exempted (sales < $5,000/year) organic farms incur production expenses of $171,978 per farm; higher than the $109,359 average for all farms nationwide[7]. Even though average production expenses are higher on organic farms than on non-organic farms, organic farms had an estimated average net income that was $20,249 per farm per year higher than the all-farm figure[7].

Organizational participation and use of conservation structures and management practices

The majority of women farmers in our survey belong to one or more types of agricultural organizations or networks. These organizations provide a range of services for women farmers, including information about production and conservation as well as the opportunity to advocate for farmers or specific production systems. Relatively large percentages of women farmers reported using recommended conservation practices. For example, conservation or reduced tillage, buffers, nutrient management, and weed and pest management techniques, such as cover crops and IPM, were practiced by more than half of farmers in our sample (with the exception of IPM for livestock production).

We hypothesized that participation in agricultural organizations will be related to a greater likelihood of adoption of conservation practices. The results related to organizational membership and participation indicate that agricultural organizations provide critical networks that support and reinforce the use of conservation practices. Membership in any organization was positively associated with adoption of several practices. Exceptions include the negative relationships between membership in general farm organizations and organic production and other practices linked to smaller scale farms (compost production, crop rotation and manure incorporation). Membership in sustainable or organic agriculture organizations was negatively related to use of IPM, which raises questions about the interpretation of conservation practices as listed on a survey such as ours. For example, IPM is an approach to managing pests by a broad range of practices, including biological, cultural, physical and chemical tactics. Its use often relies on sampling crops to determine the abundance of pests and beneficial organisms for use in decision-making about therapeutic treatment with pesticides, but also includes the pre-emptive use of genetically modified crops and pesticide-protected seed. In organic crop production systems, which were over-represented in our sample, the choice of therapeutic materials for controlling pests are extremely limited and genetically modified crops and their associated technology package (e.g., insecticide-coated seed) are not allowed. Reporting on the use of IPM may depend on the interpretation by the respondent of the specific practices involved.

In contrast, membership in a commodity producer organization increased the odds of using IPM (crops and livestock), manure transfer and nutrient management planning; while membership in a commodity producer organization decreased the odds of organic livestock production. Membership in a general farm organization decreased the odds of using compost production/application, crop rotation, manure incorporation and organic crop production. Membership in women's agriculture organizations increased the odds of adopting manure incorporation and IPM in livestock. Membership in sustainable/organic agricultural organizations increased the odds of compost production/application, cover crops, crop rotation, manure incorporation, organic crop production, soil testing, rotational or other management intensive grazing, and organic livestock production; membership in this type of group decreases the odds of adopting IPM for crops.

Of interest are those practices in which membership in one type of organization is positively associated, and membership in another organization is negatively associated, with use of particular practices. For example, the odds of using compost production/application, crop rotation, manure incorporation, and organic crop and livestock production are all increased if the farmer is a member of a sustainable/organic agriculture organization, but decreased if the farmer was a member of a general farm organization. The converse is true for IPM for crops. The success of IPM in non-organic production systems is often due to the availability of efficacious and cost-effective synthetic chemical pesticides. Many IPM systems developed for non-organic crops are based on the pre-emptive use of pest control materials (e.g., genetically modified crops and insecticidal seed treatments) or assessment of pest populations and reaction to them with the use of 'therapeutic' materials (chemical or biological) in a timely, but reactive way. In comparison with non-organic production systems, the numbers of allowable pest control materials that can be used in a reactive way in organic production systems is extremely limited and may only be used after all other approaches have proved ineffective

https://doi.org/10.1017/S1742170512000348 Published online by Cambridge University Press

(USDA National Organic Program, http://www.ams.usda.gov/AMSv1.0/nop). Often, information on the efficacy of a material allowable in organic systems for a specific pest is lacking. The cost of some allowable materials can be quite high. Therefore, even if an allowable, efficacious pest control material is available, its cost may exceed the benefit that might be gained from controlling the pest[74].

There is a likelihood that membership in these different organizations reflects larger differences in production practices, product type, farm structure and demographic characteristics. For example, members of sustainable/organic and women's farm organizations were significantly younger, had been farming for fewer years, were more likely to have formal agriculture-related education and operated fewer acres than members of other types of organizations.

Conclusions

The results indicate some support for relationships found in previous literature, but suggest the need for further consideration of the applicability of existing models for women farmers[75]. Demographic characteristics (age, education and off-farm work) found influential in previous work were not routinely associated across all areas of conservation practices in our study. We suggest the need to reconsider the causal mechanisms related to these demographics and further research their interaction with other key characteristics, such as gender, household composition and decision-making roles. The complexity of business and family arrangements on many farms, particularly farms where women play significant or primary roles, means that models which gather data on a single operator may not adequately capture the dynamics of conservation-related decisions[15,38].

This research serves as a baseline to describe conservation practices used by women farmers in the Northeast US, and some of the factors associated with their use. Based on our results, future research could investigate factors that would be likely to increase women farmers' use of conservation practices and structures on their farms, e.g., the extent to which they farm on lands likely to experience environmental degradation from agricultural practices, the extent to which they perceive environmental degradation to be a problem on their farm, their access to information about costs and benefits of conservation practices, their access to programs that support their adoption and their rate of application to those programs.

Information on women's use of conservation practices can also be used to inform policy and program development as well as techniques and strategies for reaching this growing audience with appropriate conservation information and support. Each practice had unique sets of variables linked to the likelihood of use, and farm products are the most frequent predictors of use. Consequently, the applicability of each practice is tied to the specific mix of products on each farm. As women tend to have diversified operations with multiple markets, educational and regulatory programs that attempt to reach women farmers may need to consider the specific types of farms they operate. Technicians and other personnel may need to develop in-depth knowledge of these farms to best match practices to their specific situations and goals[17,18,23,76]. Further, as only one-quarter of respondents grew up on a farm or ranch, and fewer than one-quarter received formal education in agriculture, educators and policymakers may need to determine, develop and offer support and educational programs that target the specific level of knowledge of this audience.

Acknowledgements. We thank L. Moist, A. Schwartzberg, A. Stone, R. Terman and J. Findeis for their assistance in coordinating the outreach and research efforts that made this paper possible. This research was supported in part by USDA NIFA #2009-49400-06097 awarded to C.S., M.E.B., K.B., Jill Findeis and N.E.K.

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