Opening the Farm Gate to Women?
Sustainable Agriculture in the United States

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Abstract

This paper analyzes the relationship between the growth in the number of women farmers and the rise in sustainable agriculture using the US Census of Agriculture. Assessing full time farmers, we show that farms operated by women earn much lower farm incomes than farms operated by men, such that the gender gap in agriculture is amongst the largest in any occupation. While this inequity can be partly explained by the patrilineal inheritance of land and capital, farms headed by women generate nearly 40 percent less income after controlling for farm assets, work time, age, experience, farm type, and location. We investigate whether three different forms of sustainable agriculture improved incomes for women farmers during 2012. We find that only farms engaging in Community Supported Agriculture experience a marked decline in the gender gap. We argue that the diverse set of principles associated with Community Supported Agriculture results in women selecting into that form of farming, and that the men involved in it may be more supportive of women farmers.

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1 Intro

There has been a great deal of research on the gender gap in non-farm income, but very little investigation into the gender gap in farm income. In this article, we use 2012 data from the United States Department of Agriculture (USDA) Census of Agriculture, to show that women are disproportionately likely to operate farms that engage in forms of sustainable agriculture: direct-to-consumer (DtC) sales, organic farming, or Consumer Supported Agriculture (CSA). Qualitative research connects the rise in women farmers to the rise of sustainable agriculture, noting that women farmers defined "successful farming in terms of providing services to their community, as well as in terms of profit and productivity" (Trauger et al. 2010). We argue that there are also financial incentives for women to enter sustainable agriculture, because it is less patriarchal than conventional farming. Compared with traditional farms, we find that CSA reduces the gender gap in farm income, while DtC sales and organic sales have no impact on the gender gap.

There are many possible explanations for why women farmers tend to earn lower farm incomes than their male counterparts. Our analysis highlights how patrilineal inheritance of both farmland and farm knowledge creates barriers for women farmers, and reveals a large gender gap in farm income after controlling for observable farm and farmer characteristics. This paper is also the first to provide quantitative evidence that some forms of sustainable agriculture open the farm gate to women and facilitate a reduction in the gender gap. One interpretation of our results is that the CSA movement reduces the gender gap by providing both men and women with new pathways to acquire the knowledge they need to become successful farmers.

Next, we review the literature on the historical role of women in agriculture, gender pay gaps in non-farming occupations, and the rise of women in sustainable agriculture. In Section 3 we describe the Farm Census and our method of analysis. The following section presents our evidence that the gender gap in farm income is much smaller in farms that engage in CSA than it is in conventional agriculture. Section 5 discusses our results, and Section 6 concludes.

2 Literature Review

Family farms dominate the U.S. landscape, accounting for 97 percent of all farms and 82 percent of the total value of output in U.S. agriculture (USDA 2014). Historically, the farm was a family affair, where all members contributed to the operation (Ramey 2014); yet contributions by family members were not all viewed to be equal. Instead, the discourse focused on men as 'farmers' while the women were dismissed as 'farmwives' (Shortall 1992). Despite the fact that the family farm depended on women's work for survival, women continued to work as invisible farmers (Haney and Knowles 1988). This gendered division within the family added to the marginalization of women from the exchange of knowledge as well as from important decision making roles (Leckie 1996).

While the USDA and its predecessor organizations have collected statistics on farms and farmers through the Agricultural Census since 1840, data on women farmers was not collected until 1978 (Hoppe and Korbe 2013). At that point women accounted for a mere 5 percent of principal

operators, and they made up only 14 percent of principal operators as of 2012.[1] Over the same period, women's share of other predominantly male fields also experienced roughly a threefold increase in women's share, with female doctors increasing from 11 to 34 percent, the share of female lawyers increasing from 9 to 31 percent, and their share of engineers and architects increasing from 4 to 14 percent (BLS 2012 Table 11; BLS 1978 Table B-20). Barriers to women in farming may be similar to the barriers to women in industries with entrenched patriarchal norms (see Hunt (2016) for an analysis of engineering).

While there is extensive research that explores the role of women farmers and the variation in farm output and compensation by gender in developing countries (Croppenstedt et al. 2013; Koopman 2009; Zaccaro 2011; Wa Githinji et al. 2014), few quantitative studies have investigated gender differences in agriculture in the United States (an exception is Ball (2014)). The available research in the United States clearly shows the continued "structural and cultural discrimination against women as landowners and farmers" (Pilgeram and Amos 2015). While many family businesses such as law firms or doctor offices have historically been passed down in this manner (Hauser and Featherman 1973), today modern institutions such as law and medical schools have largely replaced these patrilineal transfers. On the other hand, the transfer of the farm includes a unique commodity - the farmland itself (Laband and Lentz 1983).

The transfer of land, once an abundant resource which was given primarily to male European settlers under the Homestead Act, is now scarce. Historic legal barriers restricted women's access to land (married women in the U.S. were deprived of the right to own land under American Common Law prior to 1850 (Jensen 1991) and women's challenges to access farmland continue (Sachs 1983; Rosenfield 1985; Whatmore 1991). Women's access to farmland still depends primarily on marrying into the farm, though in some cases inheritance does occur for women - usually later in life (Pilgeram and Amos 2015). Besides access to land, researchers continue to find women being underserved in agriculture education and technical assistance (Rivera and Corning 1990; Liepins and Schick 1998), which contributes to the perpetuation of gender inequality in farming (Trauger et al. 2008).

Qualitative studies suggest sustainable agriculture may help open the farm gate to women (Trauger 2004), as part of the recent increase in women farmers is associated with women farming outside of conventional agriculture (Sumner and Llewelyn 2011). In interviews with farmers, Trauger finds that sustainable agriculture provides "spaces of empowerment for women farmers" (2004). Additionally, sustainable farming practices may substantially lower the barriers to entry for women (Pilgeram and Amos 2015) and other beginning farmers (Low and Vogel 2011) by reducing capital and land requirements, providing learning opportunities to acquire the necessary skills, improving farm income, and enabling farms to locate in urban and suburban areas as opposed to rural regions. There is evidence that suggests the recent rise in local and sustainable agriculture (Low and Vogel 2011) and niche products (Ball 2014) may be linked to increases in women's participation as principal operators, but no economic explanations as to why this may be the case have been put forth.

[1] Principal operator is the term the USDA uses for the 'head farmer' - this is the farmer that runs the farm and is in charge of the day-to-day management decisions on the farm.

To our knowledge no research has investigated whether women farmers are also underpaid relative to men. Gender inequality in agriculture may mirror gender inequality in other professions. There is significant variation in the pay gap across occupations. Compared to men full-time women earn 10 percent less as registered nurses and 11 percent less as primary school teachers, whereas women earn 33 percent less as supervisors in manufacturing and 35 percent less as financial managers (BLS 2016).[2] It is difficult to determine what portion of the gap is attributable to discrimination, and which is due to differences in worker characteristics. Regression analyses understate discrimination when they control for differences in experience and education that are themselves results of "pre-market" discrimination, while regressions may overstate discrimination when they fail to control for for unobserved differences in ability and effort (Altonji and Blank 1999). Blau and Kahn use a Blinder-Oaxaca decomposition and find a substantial unexplained gender gap still exists after controlling for education, experience, and other worker characteristics (2016). In 2010 across all non-farm occupations women earned 21 percent less than men (Blau and Kahn 2016). Only 8 percent of the pay gap can be explained by gender differences in education and experience, whereas 50 percent of the gender pay gap is attributable to differences in industry and occupation, and another 38 percent of the gender pay gap is unexplained by observable variables (Blau and Kahn 2016, Table 4).

The fact that half of the gender pay gap can be explained by difference is occupation underscores the importance of breaking down barriers in male-dominated occupations such as farming. However, there is also evidence that earnings in any occupation tend to decline as the proportion of women workers grows (Levanon, England, and Allison 2009). Since women have disproportionately entered sustainable agriculture, this dynamic may reduce the incomes of sustainable farms relative to conventional farms. Indeed many of the reasons that women-dominated caring professions are underpaid (England and Folbre 1999) may also apply to sustainable agriculture. If sustainable agriculture is seen as more feminine than conventional agriculture, it may be undervalued by society. If farmers derive intrinsic rewards from farming sustainably, they may be willing to accept lower pay. Additionally, if sustainable agriculture produces public as well as private goods, then it will be subject to free-riding and underfunding. For these reasons, this paper focuses not just on the gender gap in farm income, but also explores potential differences in farm income for farmers engaged in sustainable agriculture and conventional agriculture[3].

Organic farming emerged as a movement to counter the rise of industrial agriculture and reconnect farming to sustainable practices in terms of the community, the environment, and the food system (Sumner 2005). While organic's market share has grown tremendously (USDA 2014), it remains a niche market. Early pioneers of organic agriculture relied heavily on labor intensive methods, indicating women farmers may be more likely to engage in organic agriculture (Trauger 2004) - as previous research has indicated that women tend to select into labor intensive forms of agricultural production, relying on labor rather than capital (Rosenfield 1985).

[2] Authors' calculations

[3] For the purpose of this article, we use the term sustainable agriculture to represent farms that engage in direct-to-consumer (DtC) sales, organic farming, and Community Supported Agriculture (CSA). These are the closest proxy we can use for 'sustainable' farms in the Census of Agriculture.

CSA farms are farms that market at least some produce through CSA arrangements. The basic economic arrangement of CSA relies on members paying the farmer prior to the start of the season, thus providing them with working capital. In return the farmer provides the consumer with weekly produce during the farming season. The consumer is therefore buying a 'share' of the farm's annual harvest, lasting an average of 24 weeks[4] (Lass et al. 2003). Advocates of this model claim CSA provides a viable model of production and distribution of food by local, highly diversified farms, while creating conditions for the community and farm to join together in a "symbiotic relationship" that adequately supports the farmers (DeLind 2003).

There is little research quantifying the relationship between sustainable agriculture and gender. One recent study showed that women were actually less likely to engage in DtC farming than conventional agriculture (Low and Vogel 2011). The only national study investigating CSA farms found that women made up 34 percent of principal operators of CSA farms -- four times their share of conventional farms in the 1997 Census (Lass et al. 2003). These findings were corroborated by a study finding women were more likely to be principal operator in CSA than conventional agriculture (Galt et al. 2012). While women were much more likely to be farmers on CSA operations than in conventional farming, they were still underrepresented as head farmer, pointing to the persistence of gender inequities. No study has yet made use of new questions in the Agriculture Census on sustainable farms to systematically analyze the role of women in sustainable agriculture.

3 Data and Methodology

This paper uses data from the 2012 USDA Census of Agriculture, the most recent census available, on nearly 1.4 million farms. The survey's sampling weights make this data representative of all 2.1 million farms in the United States, as defined by the USDA. According to the USDA, a farm is "any place that produced and sold - or normally would have produced and sold - at least $1,000 of agricultural products during a given year" (Hoppe and MacDonald 2013). However, most of the farms in the USDA data generate very little farm income, with 75 percent of all farms having less than $50,000 in *total sales* per year according to the census. Since this paper analyzes the gender gap in farm income, we restrict the sample to the 15 percent of farms that had at least $10,000 in farm sales, had a full-time and non-retired principal operator, and provided complete data for all our key variables.[5] We choose the $10,000 cutoff based on the USDA Economic Research Service finding that small acre farms with at least $10,000 in farm sales had positive net farm incomes (Newton 2014). This reduces our sample to 232,866 responses, representing 309,233 farms.[6]

[4] This varies by region, as some areas have longer or shorter growing seasons.
[5] In the USDA Data, a "full-time operator" is defined as someone spending at least 50 percent or more of their worktime on the farm work. Retired is self-reported. The question asks "Is this operator retired?"
[6] The cut-off disproportionately reduces the number of women farmers in our sample since women farmers are about 50 percent more likely to operate farms with less than $10,000 in sales than male farmers.

We stratify our sample into three subcategories to provide summary statistics for sustainable agriculture. While there is debate about what sustainable farming means, the literature frequently associates local and organic farming with sustainable agriculture (Adams, Salois 2010; Schnell 2013). In this paper we use the term sustainable to designate farms that engage in direct-to-consumer sales, organic farming, or Community Supported Agriculture.

For direct-to-consumer sales, the Census asks farmers if they have produced, raised, or grown any crops that were sold directly to individual consumers. This includes activities such as having a roadside stand, selling at the farmers market, selling pick-your-own crops, etc. The next category, farms with organic sales, consists of farms that had some organic sales according to the National Organic Program standards (Heckman 2006). Finally, CSA farms are farms that market at least some produce through CSA arrangements. There is some overlap between these categories, as many farms engage in more than one of these practices.

[Table 1 about here]

Table 1 presents variable means for both the full census and our sample. A growing number of farms engage in various types of sustainable agriculture. Within our sample, roughly 6 percent of farms report direct-to-consumer sales, 2 percent of farms report sales of organic produce, and 1 percent of farms engage in CSA. Table 1 compares these farms to the rest of farms in our sample and all farms in the general census.

While women are the principal operators of 14 percent of all farms in the US, they operate only five percent of farms in our sample. This is consistent with the literature, as women tend to operate farms with low net farm sales (Hoppe and Korbe 2013). However, sustainable farms are more likely to be run by women than conventional farms. While women make up five percent of principal operators for all farms in the sample, they make up 13 percent of operators of farms with direct-to-consumer sales, 12 percent of farms with organic sales, and 22 percent of farms engaged in CSA. Women are more than four times as likely to be the principal operator on CSA farms compared to conventional, but the Agriculture Census shows that women make up a smaller fraction of CSA farmers than Lass et al. found in their survey (2003).

Table 1 provides descriptive statistics for all our samples. Although the value of farm sales is $160,202 for all farms in the Census, restricting the sample to farms with at least $10,000 in farm sales raises average net farm sales to $673,543. Not surprisingly, the farms in our sample also report owning more machinery, buildings, and land - thus having higher net farm assets. These larger farms spend more on hired and contracted labor, and report more full-time operators per farm.[7] Full-time operators are farmers who indicate that farming is their primary occupation. By combining data on the number of farm operators and the number of days each operator spends working *off* the farm, we calculate an upper-bound on the number of days the operators spend working on the farm. We use this to construct the variable "annual number of farmer-days". We find that farms in our sample have almost twice as many farmer days than the full census. Farms

[7] In the literature, farm size is measured in terms of sales, thus in this paper 'larger' refers to farms with more sales.

in our sample also report a mean net farm income[8] of $254,569 annually – over six times as much as the mean net farm income across all farms in the census.

Our data shows that counties with a higher density of sustainable agriculture tend to have more farms operated by women. For each county, we calculate the percentage of farms with a woman principal operator as well as the percentages of farms with direct-to-consumer sales, organic produce, or Consumer Supported Agriculture. Using the full sample, the correlations between the percent of women-run farms and the DtC, organic, and CSA farms are 0.50, 0.31, and 0.39, respectively. Figure 1 illustrates this geographical correlation between women farmers and CSA farms. Farms on the East and West coasts are disproportionately likely to have a woman principal operator and they are also more likely to be CSA farms.

[Figure 1 about here]

Table 2 presents our sample stratified by the gender of the principal operator. These findings shed light on the variation between farms with a man or woman principal operator. Farms operated by men tend to be larger in terms of sales and acreage and earn more than twice as much net farm income as farms operated by women. Women on the other hand are more likely to run sustainable farms and are twice as likely to be a 'beginning farmer', which the USDA defines as a farmer with less than ten years of experience. These summary statistics do not tell the complete story however, as men principal operators spend more days working on the farm and they tend to have more machinery, buildings, and farmland to utilize than women farmers.

[Table 2 about here]

This paper quantifies the gender gap in farm incomes using econometric techniques that are similar to those used to estimate the gender gap in wage income. Specifically, we estimate the following equation:

$$\ln(\textit{net farm income}_i) = \beta_0 + \beta_1 \textit{woman PO}_i + \beta_2 \ln(\textit{farmer days}_i) + \beta_3 \ln(\textit{farm assets}_i) + \beta X_i \qquad (1)$$

This regression tests whether women operators earn lower farm incomes, after controlling for the fact that their farms tend to rely on slightly fewer farmer days and substantially smaller farm assets[9]. In our preferred model, we also control for the principal operator's age and experience, and sixteen farm types, and state-level fixed effects. We interpret β_1 as the unexplained gender gap in farm income, analogous to the unexplained gender gap in wages.

Next, we estimate the gender gap in farm income in the three types of sustainable agriculture outlined above by estimating the following equation:

$$\ln(\textit{net farm income}_i) = \beta_0 + \beta_1 \textit{woman PO}_i + \beta_2 \ln(\textit{farmer days}_i) + \beta_3 \ln(\textit{farm assets}_i) + \beta X_i$$

[8] Net farm income is the sum of the sales of commodities, other miscellaneous farm-related sales and government payments (gross farm income), less expenses and depreciation.

[9] As a robustness check, we use the number of full-time principal operators rather than number of farmer days as our measure of farming labor. The results of these regressions are qualitatively similar to those we report in this paper.

$+ \beta_4 \text{sustainable ag.}_i + \beta_5 \text{ woman PO}_i * \text{ sustainable ag.}_i$ (2)

Specification 2 interacts women principal operator with direct-to-consumer sales, farms with organic sales, and farms engaged in CSA. Given the fact women are disproportionately likely to operate direct-to-consumer, organic, and CSA farms, we hypothesize that the gender gap will be smaller for farms engaged in sustainable agriculture.

4 Results

Our estimates from Specification 1 are presented in Table 3. Column (1) shows that net farm income increases with the number of days worked by the farms' operators. Controlling for farmer days, we also find that farms run by women earn much smaller farm incomes than farms run by men. Our estimate of β_1 suggests that, controlling for farmer days, net farm income is 1.16 logs or 69 percent, lower for farms with a woman principal operator. While this specification is incomplete, it provides an important benchmark for understanding the gender gap in farm incomes.

[Table 3 about here]

Part of the reason that women farmers tend to earn lower farm incomes is that they manage farms with less capital. Column (2) controls for the value of farm assets, including machinery, buildings, and land owned by the farm. Doing so reduces our estimate of the gender gap in farm income to 0.79 logs or 55 percent. In other words, about a third of the difference in farm income across gender can be explained by the fact that women tend to operate farms with less capital.[10] The results from Column (2) do not necessarily imply that there is greater gender equity in farming than is suggested by the results in Column (1). After all, men tend to run larger farms than women in part because they are more likely to inherit farmland and capital from their fathers, and there is nothing equitable about patrilineal inheritance.

A range of other factors could explain this gap in farm incomes. In Column (3) we control for the age and experience of the principal operator, which reduces the farm income gap from 0.79 to 0.67 logs (55 to 49 percent). We add fixed effects for 16 different types of farms and all 50 states in Column (4) and find a gender gap in farm incomes of 0.50 logs, which implies that farms run by women earn 39 percent less than comparable farms run by men. Our full specification is still unable to explain 43 percent of the gender gap in (log) income from Column (1). Still, our final estimate of the gender gap in farm incomes cannot be interpreted as a measure of discrimination in agriculture for two reasons. First, to the extent that we control for factors that are themselves subject to discrimination, including capital and experience, our estimates are downwardly-biased. Second, since not all differences between men and women farmers are observable in our data, our estimates may be upwardly biased. Nevertheless, our measure of the gender gap in farm income is much larger than the wage gap in most occupations, and it can also shed some light on the achievements and failures of the growth of women in agriculture.

[Table 4 about here]

[10] Due to data limitations, we cannot identify if farms were inherited.

In Specification 2, presented in Table 4, we allow for the gender gap in net farm income to vary across our three different types of sustainable farms. First, we examine farms with at least some direct-to-consumer sales. After controlling for farmer-days and farm assets, we find that farms with direct-to-consumer sales tend to earn log incomes that are 0.34 lower (29 percent) than our sample as a whole. We also find no evidence that the gender gap in farm income is significantly smaller for farms that sell directly to consumers. Our finding that DtC farms earn lower net farm incomes compared to other farms has yet to be discussed in the literature.

Next, we consider farms that sell at least some organic products. Like farms with DtC sales, our results indicate that organic farms tend to earn lower net farm incomes than conventional farms. We also find no strong evidence of reduced gender inequality among organic farms either. The estimates on the interaction between organic and women principal operator in Column (2) are not statistically different from zero, and the point estimate is small -- less than a fifth of our estimate of the gap in farm income.

Finally, we estimate the gender gap among farms engaged in Community Supported Agriculture. Like DtC farms and organic farms, we find that CSA farms earn lower incomes than conventional farm. However, among CSA farms we also find a much smaller gender gap in farm income. The estimates in Column (3) show that while the gender gap in log farm income is 0.50 for all farms in our sample, it is 0.23 for farms engaged in CSA. In percentage terms, our results suggest that women earn 39 percent less than men running conventional farms, while they earn 26 percent less than men running CSA farms - thus reducing the gender gap by one third.

The lower net farm income observed for farms engaged in DtC and CSA could be explained by the fact that these farms may represent forms of civic agriculture rather than capitalist agriculture. Qualitative studies argue that DtC and CSA farms work to promote environmental, social, and economic development within their communities (Hinrichs 2000; Paul forthcoming), breaking away from the profit-maximizing models within conventional agriculture. Differences in the priorities of the farm may explain the lower net farm income observed in these instances.

5 Discussion

Women make up a growing share of principal operators, especially on farms engaged in sustainable agriculture. Nevertheless, concerns about gender equity in agriculture remain. First, we show that women are more likely to operate smaller farms in terms of both sales and acreage. Second, this paper documents a substantial gender gap in farm income. Controlling for differences in farm and farmer characteristics, we find that women earn net farm incomes 39 percent lower than men.

This paper also addresses whether sustainable agriculture promotes gender equity in farming. By focusing on the variation in the gender gap in the three different types of sustainable farming we investigate - DtC, Organic, and CSA - we are able to provide insight into the role of new institutions in breaking down gender inequities in agriculture.

We first investigated DtC. Of all the sustainable models, this is the oldest form of agriculture. Although farms selling to their neighbors and communities is not new, the United States has undergone a significant resurgence in local agriculture. The rise of local food campaigns, such as "know your farmer, know your food" (USDA 2016) has increased the visibility of farmers and strengthened community ties to farms. Nevertheless, we find no evidence that the gender gap in farm income is lower among DtC farms.

Our results also find that organic agriculture does not reduce the gender gap in farm income. Despite women being more likely to farm in organic agriculture, we find no evidence that economic profitability is influencing this transition. The failure of organic to mitigate the gender gap is likely due to the co-optation of organic agriculture by industrial agriculture, resulting in the adoption of standards in place of process (Guthman 2014), thus breaking little from the traditions within conventional agriculture.

The failure of DtC and organic farming to substantially close the gender gap is related to the finding that they do not represent a significant shift away from conventional farming. For instance, farming methods, the transfer of the farm itself, and avenues to acquire farming knowledge have not been fundamentally altered. Thus, organic and DtC farming, like conventional, have not provided women farmers with the 'space' they could have.

Of these three forms of sustainable agriculture, only CSA lowers the gender gap on net farm income. While the gender gap is smaller among CSA farms, it is still substantial and comparable to occupations such as physicians and surgeons, software developers, postsecondary teachers, and designers.[11] However, since CSA farms also earn substantially less than conventional farms, women farmers earn about 6 percent lower incomes by starting a CSA farm compared to a conventional farm. Unlike DtC and organic agriculture, the CSA movement fundamentally alters many aspects of traditional agriculture and the farm itself - such as shedding patriarchal norms- which can explain the reductions in the gender gap and the increased participation of women principal operators in CSA farming.

First, CSA improves equitable access to knowledge on the farm which has traditionally been passed down in predominantly a patrilineal fashion – excluding both women and new farm entrants from accessing vital knowledge for running the farm. The historical exclusion of information and knowledge about the farm and farming practices to women has been detrimental to their ability to enter the occupation (Leckie 1996). Because CSA is more accessible to the community, these CSA farms are also more accessible to young farmers looking to acquire skills and enter the profession. CSA farmers frequently offer apprenticeship programs (Ekers 2015), where the next generation of farmers acquire skills and knowledge vital to the farming process. These farm apprenticeship programs create an alternative egalitarian transfer of knowledge between generations of farmers that is not linked to heredity and patriarchy, providing valuable knowledge and greater opportunity for women farm entrants.

[11] Authors calculations of the Bureau of Labor Statistics, "Labor Force Statistics from the Current Population Survey." available at http://www.bls.gov/cps/cpsaat39.htm (last accessed August 2016).

Another possible explanation for the reduction in the gender gap for CSA farmers is their alternative mechanisms for dealing with risks on the farm. Conventional farming is inherently risky, in part due to natural weather phenomenon, and in part due to chemically intensive monoculture growing practices (Hardaker 2004), and men may select into the profession at higher rates than women and earn higher net incomes than women farmers because women may be more risk averse (Jianakopolis and Bernasek 1998). The CSA model provides farmers with new institutions for hedging risk, which may open the farm gate to women. Unlike conventional agriculture, the CSA model allows farmers to share risk with their community. Members of the CSA purchase a share of the harvest, so if there are 100 members, each member will receive 1/100 of the harvested product. This protects the farmer against shocks such as extreme weather events or pest infestations, as they have already sold the share prior to the shock. The other risk-sharing mechanism comes through the agroecological diversity on the farm. Rather than relying on a small handful of crops, as is the case in modern-day monocultures, CSA farmers grow dozens of crops, relying on crop diversity to reduce risk. Crop diversity allows for multiple plantings and harvestings, reduces the likelihood of pest infestations, and mitigates changes of disease. This high level of diversification facilitates long-term crop rotations, which further reduces the risk of crop failure. By reducing the risk involved with farming, CSA may attract women and reduce the gender gap in farm income between risk-loving men and risk-averse women.

Finally, CSA has a diverse set of principles – centered around civic agriculture – that are integral to the success of CSA farms (Paul forthcoming). The principles of the CSA movement go beyond the profit maximizing behavior of typical conventional farms, and may explain why women farmers are drawn to this form of agriculture, and hence more likely to engage in CSA farming. Additionally, the principles involved in CSA farming suggest male farmers engaged in it may be more supportive and receptive to women farmers. Farmers are not engaging in this work out of profit maximizing behavior, but are working towards a lifestyle and a broader reward system, as CSA farming involves various forms of non-market value, such as providing food for your community and engaging in agricultural work that can have positive environmental outcomes. In this respect, the intrinsic motivations for farmers to engage in CSA might also make it a form of work that pays both men and women less than they could earn in conventional agriculture.

These findings should be informative to policy makers as they strive to improve access to the farm and farming for women, while simultaneously working to eliminate the gender gap which we have identified in agriculture. There are very few programs in place to help serve women farmers despite the substantial size of the USDA and its funding sources. Currently, the USDA identifies women and minorities as "socially disadvantaged farmers" which allows the USDA to target loan funds towards these groups (Farm Service Agency 2016). While this is a small step in the right direction, the program remains very small and does not have the size, nor scope, to address the gender gap nor the underrepresentation of women farmers.[12] Starting a farm requires

[12] For example, the USDA has allocated $10 million per year under the 2014 Farm Bill for the 2501 Program, which provides outreach and assistance for socially disadvantaged farmers and ranchers and veteran farmers and ranchers. See http://www.outreach.usda.gov/sdfr/.

significant sums of capital that cannot be met by programs such as this. Additionally, training programs geared to supporting the type of agriculture that women are interested in engaging in and providing risk hedging programs for diversified farms (Paul forthcoming) could go a long way improving women's access to and success on the farm.

6 Conclusion

This paper reveals substantial gender inequity in US agriculture. While our estimate of the gender gap in farm income is larger than the average gender pay gap in the US today, it falls within the range of gender gaps in other eras, countries, and male-dominated occupations. Controlling for worker and occupation characteristics, US women earned 35 percent less than men in 1979 (Altonji and Blank 1999, 3159), and Japanese women earned 57 percent less than men in 1993-1994 (Blau and Kahn 2003). In 2016, the raw gender wage gap was 40 percent in the law profession, and 30 percent amongst financial analysts (BLS 2016). In our fully specified model in Table 3, Column (4), we find a gender gap in farm income of 39 percent, which suggests that farming is among the most unequal professions.

Given the simultaneous rise of women farmers as principal operators and increased number of sustainable farms, we analyze the link between these two phenomena. While the role of women farmers in sustainable agriculture has been investigated before through qualitative studies, this is the first quantitative study that estimates the gender gap in conventional agriculture and compares it to the gender gap in sustainable agriculture. We find no evidence that DtC sales or organic farming reduce and gender gap in farm income, but we estimate that CSA arrangements reduce the gender gap by about a third. This provides the basis for our argument that CSA farms are opening the farm gate for women.

While this is a first look at a gender gap in agriculture, much additional work is needed to investigate the dynamics at play. First, a shortcoming in our dataset is that we cannot observe education. While farming requires both formal, and informal education, we believe data exploiting variation in human capital beyond experience may be fruitful. Viewing formal schooling may not significantly change the results, as women now have higher levels of schooling than men (Blau and Khan 2016). Second, our analysis here is limited to the 2012 Census. An analysis of the gender gap over time using panel data would reveal whether, and to what extent, the increase in women principal operators has helped close the gender gap in farm income. Finally, qualitative research which interviews women in sustainable agriculture, and CSA in particular, could help researchers better understand their economic and intrinsic motivations for opting into sustainable agriculture.

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Tables and Figures

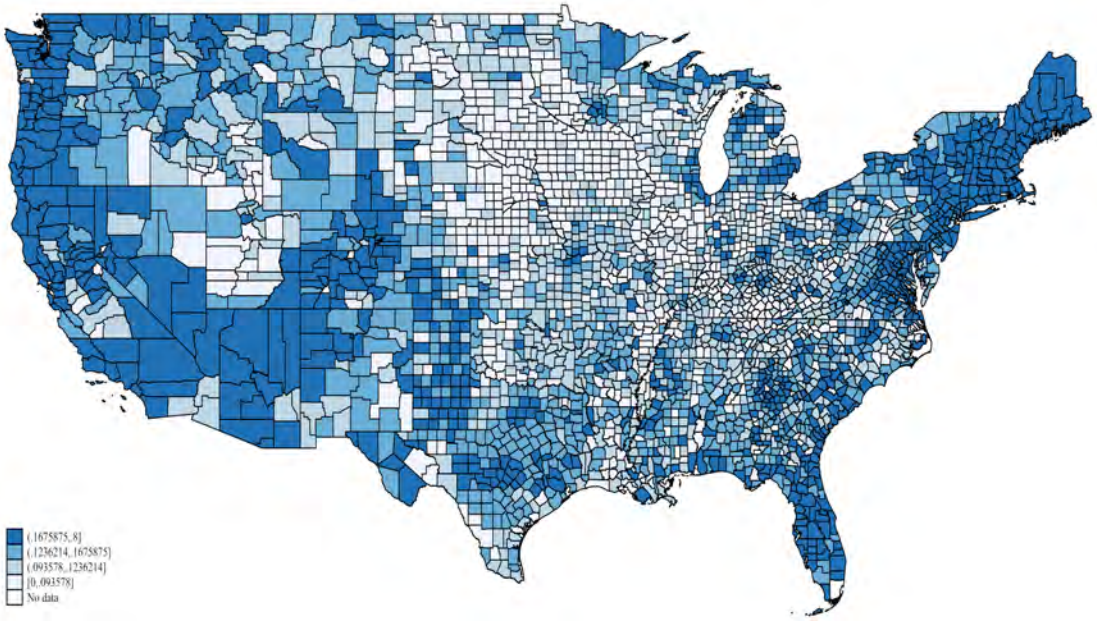
Table 1: Sample Means of Key Variables for Different Types of Farms

	Full sample	Restricted sample			
	All farms	All farms	Farms with Direct-to-Consumer Sales	Farms with organic sales	Farms with Consumer Supported Agriculture
Woman principal operator	0.14	0.05	0.13	0.12	0.22
Number of women operators	0.46	0.34	0.55	0.55	0.69
Number of full time operators	0.67	1.38	1.47	1.49	1.52
Annual number of farmer-days	289	482	509	535	515
Farm sales	160,202	673,543	356,051	803,929	269,766
Value of machinery	115,662	373,024	191,732	234,975	140,275
Value of land and buildings	720,123	1,699,665	1,007,377	1,282,636	672,026
Value of all assets	835,785	2,072,689	1,199,109	1,517,612	812,299
Acres operated	433.6	1,250	618.4	589.4	319
Sales per acre operated	369	539	576	1364	846
Net farm income	43,750	264,569	136,666	245,125	103,675
Farms with Direct-to-Consumer Sales	0.07	0.06	1	0.38	0.76
Farms with Organic Sales	0.01	0.02	0.14	1	0.38
Farms with Community Supported Agriculture	0.01	0.01	0.12	0.17	1
Years of experience for PO on any farm	24	29.4	23.8	20.9	17.8
Beginning principal operator (exp < 10)	0.2	0.12	0.21	0.26	0.39
Spending on all labor	15,861	51,529	50,731	183,449	52,807
Observations	1,382,099	232,866	13,583	4,733	2,044
Population represented	2,109,303	309,233	18,884	6,690	2,995

Note: This table reports means of the sample, using the appropriate weights. Our full sample includes all 1,382,099 farms that provided information on all these variables to the US farm census, which represent 2,109,303 farms. The "restricted sample" is limited to farms with at least $10,000 in sales, full-time, non-retired principal operators, and data on all our key variables.

Figure 1

Fraction of Farms with a Woman Principal Operator



Fraction of Farms Using CSA

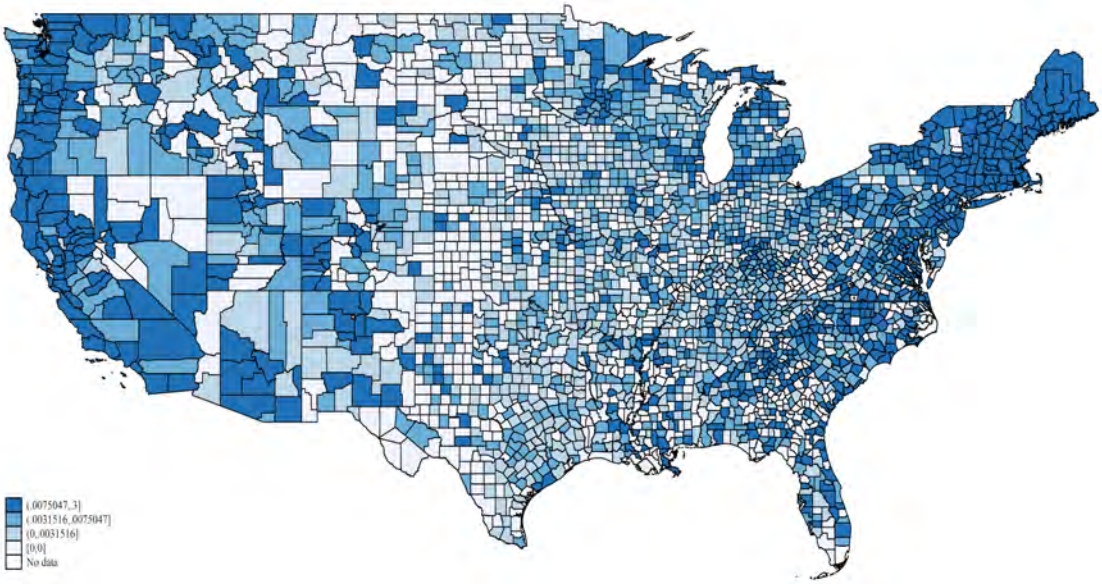


Table 2: Sample Means for Farms Led by Men and Women

	Farms with Men Principal Operators	**Farms with Women Principal Operators**
Number of full time operators	1.38	1.37
Annual number of farmer-days	482	465
Farm sales	697,530.00	258,148.00
Value of all assets	2,122,802.00	1,204,860.00
Acres operated	1,282	701
Net farm income	273,094.00	116,928.00
Farms with Community Supported Agriculture	0.01	0.016
Farms with Direct-to-Consumer Sales	0.06	0.14
Farms with Organic Sales	0.02	0.05
Years of experience for PO on any farm	29.3	22.9
Beginning principal operator	0.11	0.22
Spending on all labor	52,625	32,544
Age of principal operator	55.3	56
Observations	221,264	11,602
Population represented	292,351	16,882

Note: These means are for our restricted sample discussed in Table 1.

Table 3: Effect of Women Principal Operator on Net Farm Income				
	(1)	(2)	(3)	(4)
Women Principal Operator	-1.164***	-0.789***	-0.6742***	-0.4984***
	(0.0181)	(0.0177)	(0.0179)	(0.0166)
Log Farm Days Worked	0.77828***	0.4508***	0.4722	0.4382***
	(0.0082)	(0.0077)	(0.0077)	(0.0075)
Log Total Farm Assets		0.5388***	0.5419	0.4957***
		(0.0033)	(0.0034)	(0.0034)
Age of principal operator			-0.0116***	-0.0133***
			(0.0023)	(0.0022)
Experience of Principal Operator			0.026***	0.0245***
			(0.0012)	(0.0011)
Farm Type Fixed Effects	N	N	N	Y
State Fixed Effects	N	N	N	Y
Observations	232,866	232,866	232,866	232,866
Population Size	309,233	309,233	309,233	309,233
R-squared	0.0724	0.0724	0.2825	0.3766

Notes: OLS regressions of women principal operator on log net farm income and control variables. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Effect of Local Agriculture Institutions on Gender Gap			
	(1)	(2)	(3)
Women Principal Operator	-0.4857***	-0.4993***	-0.5027***
	(0.0177)	(0.0170)	(0.0169)
Log Farm Days Worked	0.44388***	0.4399***	0.4396***
	(0.0074)	(0.0075)	(0.0075)
Log Total Farm Assets	0.492***	0.4951***	0.4950***
	(0.0034)	(0.0034)	(0.0034)
Age of principal operator	-0.0123***	-0.0132***	-0.0132***
	(0.0022)	(0.0022)	(0.0022)
Experience of Principal Operator	0.024***	0.0242***	0.0242***
	(0.0011)	(0.0011)	(0.0011)
Farm has DTC	-0.3414***		
	(0.0155)		
DTC X Women PO	-0.0019		
	(0.0474)		
Farm has Organic		-0.2288***	
		(0.0259)	
Organic X Women PO		0.0891	
		(0.0777)	
Farm has CSA			-0.3395***
			(0.0406)
CSA X Women PO			0.2734***
			(0.0841)
Farm Type Fixed Effects	Y	Y	Y
State Fixed Effects	Y	Y	Y
Observations	232,866	232,866	232,866
Population Size	309,233	309,233	309,233
R-squared	0.3786	0.3769	0.3769

Note: OLS regressions of women principal operator on net farm income and controls. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1