

# An Assessment of Four Bridging Options of Agricultural Producer Demographics for the 2012 and 2017 Census of Agriculture

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## Abstract

Changes to survey questionnaires to reduce the underrepresentation of young and female agricultural producers have complicated comparisons between the 2012 and 2017 Census of Agriculture producer demographics. Using content test data, four bridging options for the 2012 and 2017 Census of Agriculture are assessed. After constructing four groups of primary producers by following the guidelines of four hypothetical bridging options, estimates of producers' ages, occupational statuses, and sex are compared. The results indicate that the primary producers identified using the four bridging options are relatively comparable in terms of their ages and occupational statuses. However, women are represented at much higher rates among primary producers selected with strategies that prioritize their role or function on the operation during the selection process. The implications of these results for drawing comparisons between 2012 and 2017 agricultural producer demographics are discussed.

**Key Words:** Women in Agriculture, Census of Agriculture, Demographics

## 1. Introduction

According to the National Agricultural Statistics Service's (NASS) Census of Agriculture (2014), after years of steadily increasing, the percentage of women who operate a farming or ranching establishment plateaued at about 14% between 2007 and 2012, a point of concern among policy-makers and members of the agricultural community. Following the release of the 2012 farm operator statistics, NASS found no shortage of criticism from media outlets, policy-makers, and members of the agricultural community, who called into question the lack of representation of young and female operators in its publications of farm operator demographics. For example, one outlet criticized both the accuracy and comprehensiveness of the Census of Agriculture's estimates of female representation among farm operators, and said that they would be more "complete if the census asked more specific questions about who does what kind of work" (Runyon, 2014, p. 4).

The underrepresentation of women in US agriculture is not a new phenomenon. Although women have historically played a vital role in US agriculture, several studies have pointed out that women's contributions to agriculture often go unnoticed (Sachs, 1983; Rosenfeld, 1985). This may be partly due to the gendered division of labor on American farms. Men and women often contribute to agricultural operations in ways that are consistent with traditional gender roles (Gregory, Bell, Jarnagin, and Bauer, 2000; Trauger, 2007). However, when women do perform the work traditionally performed by males, their contributions often go unrecognized. Therefore, the underrepresentation of women on the Census of Agriculture may be exacerbated because it is

masked or devalued within a community that is male dominated, or performed in a completely different domain altogether (e.g. within the farmhouse).

### 1.1 Expert Panel on Statistics on Women and Beginning Farmers in the USDA Census of Agriculture

As a result of the negative feedback received, NASS assembled a panel of experts to review current questionnaires and provide recommendations on how to more comprehensively capture the contributions of female operators. The panel was asked to review a host of survey materials, tables, and questions for consideration, such as Figure 1 below. Following the expert review, the panel provided NASS with several recommendations (additional information on the panel recommendations can be found in the *Report of the Expert Panel on Statistics on Women and Beginning Farmers in the USDA Census of Agriculture*).

SECTION 35 OPERATOR CHARACTERISTICS			
1. In 2012, how many operators (individuals) were involved in the day-to-day decisions for this operation? Enter the number of operators and the number of women operators. Exclude hired workers unless they were a hired manager or family member. . . . 1575	Total Number of Operators	1574	Number of Women Operators
2. Answer the following questions for up to three primary operators of this operation as of December 31, 2012.	Principal Operator or Senior Partner	Operator 2	Operator 3
a. Full name . . . . .	1835	1852	1872
b. Sex of operator . . . . .	0926 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female	1586 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female	1597 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female
c. Is operator 2 or 3 the spouse of the principal operator? . . . . .	1590 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1601 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	
d. At which occupation did the operator spend the majority (50 percent or more) of his/her worktime in 2012?	0928 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Other	1580 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Other	1591 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Other
e. Is this operator retired? . . . . .	0924 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1582 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1593 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No
f. How many days did the operator work off the farm in 2012? Include days in which the operator worked at least 4 hours per day in an off-farm job. Include work on someone else's farm for pay. . . . .	0929 1 <input type="checkbox"/> None 2 <input type="checkbox"/> 1 - 49 days 3 <input type="checkbox"/> 50 - 99 days 4 <input type="checkbox"/> 100 - 199 days 5 <input type="checkbox"/> 200 days or more	1831 1 <input type="checkbox"/> None 2 <input type="checkbox"/> 1 - 49 days 3 <input type="checkbox"/> 50 - 99 days 4 <input type="checkbox"/> 100 - 199 days 5 <input type="checkbox"/> 200 days or more	1931 1 <input type="checkbox"/> None 2 <input type="checkbox"/> 1 - 49 days 3 <input type="checkbox"/> 50 - 99 days 4 <input type="checkbox"/> 100 - 199 days 5 <input type="checkbox"/> 200 days or more

Figure 1: Portion of the 2012 COA questionnaire reviewed by the expert panel

The recommended changes to the census form centered around two major issues identified by the panel. First, the panel asked NASS to recognize the difficulty in measuring modern farm organizations, which have evolved and become increasingly complex. Secondly, the panel stated that there are cultural norms within agricultural operations that disproportionately assume that older men are in positions of leadership, regardless of their day-to-day involvement of the operation of the farm.

Several recommendations were proposed to address these overarching issues. It was recommended that NASS remove the operator and principal operator labels from its forms as they may have masculine connotations. As an alternative, it was recommended that they ask about persons involved in the day-to-day decisions on the operation more generally. Furthermore, it was recommended that NASS ask about people's involvement in a variety of agricultural decisions on the COA, and that principal operators be defined primarily on the basis of their role or function within agricultural operations.

The panel further recommended that NASS collect information from up to four operators instead of three in the demographics table, with the reasoning being that in operations run by two couples, the wife of the second husband may be disproportionately excluded from the form--thereby depressing the estimates of female farm operators. In addition, it was recommended that NASS retain a survey item asking respondents to identify principal operators to allow for comparisons of principal operator characteristics over time. Although respondents designated a single principal operator using the first column of the demographics table on previous censuses, the panel recommended that respondents be allowed to designate up to four decision makers as principal operators on the 2017 form to allow for joint involvement.

SECTION 7 PERSONAL CHARACTERISTICS		Men		Women	
1. In 2017, how many men and women were involved in decisions for this operation (Include family members and hired managers)? Exclude hired workers unless they were a hired manager or family member. . . . .		1571		1574	
2. Answer the following questions for up to four individuals who were involved in the decisions for this operation as of December 31, 2017.					
		Person 1	Person 2	Person 3	Person 4
		1836	1852	1872	1873
a. Full name . . . . .					
b. Is this person completing this form?		1610 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1611 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1612 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1613 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No
c. Sex . . . . .		1926 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female	1586 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female	1597 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female	1614 1 <input type="checkbox"/> Male 2 <input type="checkbox"/> Female
d. What was this person's age on December 31, 2017?		1925 <input type="text"/> age	1585 <input type="text"/> age	1596 <input type="text"/> age	1615 <input type="text"/> age
e. Is this person of Hispanic, Latino, or Spanish origin? . . . . .		1927 Hispanic, Latino, or Spanish origin 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1587 Hispanic, Latino, or Spanish origin 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1598 Hispanic, Latino, or Spanish origin 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No	1622 Hispanic, Latino, or Spanish origin 1 <input type="checkbox"/> Yes 3 <input type="checkbox"/> No
f. Race . . . . .		<b>Mark one or more.</b> 2701 <input type="checkbox"/> White 2702 <input type="checkbox"/> Black or African American 2703 <input type="checkbox"/> American Indian or Alaska Native. Specify tribe <input type="text"/> 2733 <input type="text"/> 2705 <input type="checkbox"/> Asian 2704 <input type="checkbox"/> Native Hawaiian or Other Pacific Islander	<b>Mark one or more.</b> 1801 <input type="checkbox"/> White 1802 <input type="checkbox"/> Black or African American 1803 <input type="checkbox"/> American Indian or Alaska Native. Specify tribe <input type="text"/> 1833 <input type="text"/> 1805 <input type="checkbox"/> Asian 1804 <input type="checkbox"/> Native Hawaiian or Other Pacific Islander	<b>Mark one or more.</b> 1901 <input type="checkbox"/> White 1902 <input type="checkbox"/> Black or African American 1903 <input type="checkbox"/> American Indian or Alaska Native. Specify tribe <input type="text"/> 1933 <input type="text"/> 1905 <input type="checkbox"/> Asian 1904 <input type="checkbox"/> Native Hawaiian or Other Pacific Islander	<b>Mark one or more.</b> 1616 <input type="checkbox"/> White 1617 <input type="checkbox"/> Black or African American 1618 <input type="checkbox"/> American Indian or Alaska Native. Specify tribe <input type="text"/> 1619 <input type="text"/> 1620 <input type="checkbox"/> Asian 1621 <input type="checkbox"/> Native Hawaiian or Other Pacific Islander
g. At which occupation did this person spend the majority (50 percent or more) of his/her worktime in 2017? . . . . .		1928 <b>Mark one.</b> 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Work other than farming or ranching	1580 <b>Mark one.</b> 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Work other than farming or ranching	1591 <b>Mark one.</b> 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Work other than farming or ranching	1623 <b>Mark one.</b> 1 <input type="checkbox"/> Farm or ranch work 2 <input type="checkbox"/> Work other than farming or ranching

Figure 2: Portion of the revised COA Content Test questionnaire

### 1.2 Expert Panel on the Publication of Farm Operator Demographics

NASS implemented these changes in the 2015 Census of Agriculture Content Test and the 2016 Census of Agriculture Electronic Data Reporting Test. Several issues became readily apparent, however. The 2012 publications reporting the demographic characteristics of principal operators only reported the information for a single person for each operation. Allowing respondents to designate multiple principal operators on their establishments increased the difficulty of producing summaries of principal operators and comparing operator characteristics over time. How can the demographic characteristics of a single principal operator be summarized for publications when respondents designate more than one principal operator on the operation?

To answer this question NASS sought guidance from a second panel of experts. The panel was charged with considering how to allow for the continuity of publications of principal operator summaries, given that respondents could now designate multiple principal operators for their operation on the census form. More specifically, input was needed on how to identify one of these principal operators to serve as the sole principal operator for the establishment. In addition, NASS sought feedback on the vernacular to reference principal operators, given the recommendation of the previous panel to remove the operator and principal operator term from the census form.

The panel urged NASS to fully abandon the usage of the terms operator and principal operator altogether. According to the panel, the terms operator and principal operator are outdated, loaded, and fail to adequately resonate with agricultural decision-makers today. Instead, NASS was instructed to adopt the terms producer and principal producers as a substitute in all subsequent publications. For the purposes of bridging the data series to draw comparisons to previous principal operator summaries, the panel recommended that the term primary producer be used to reference the sole principal producer selected to represent the operation.<sup>1</sup>

To identify a primary producer for bridging analyses, the panel recommended the following algorithm: Producers were to first be ranked by their level of decision-making involvement and then by the number of days they work off the farm. The panel asserted that should producers have equal levels of decision-making involvement and spend an equal number of days working off the farm, then one should be chosen at random to serve as the primary producer. In essence, the panel suggested that NASS not only change how they refer to and collect data about producers, but by extension also how they operationalize primary producers for the purposes of analyses.

Although the panel provided clear guidance on how to identify a primary producer for each operation, other potential solutions for bridging primary producer summaries are available. For instance, similar to previous COAs, one could simply summarize the information provided for the producer listed in the first column of the demographics table. A second alternative is to define primary producers based on their role or function on the operation, but prioritize the order in which they are reported instead of randomly selecting a producer. Finally, a third alternative is to use a modeling approach that encompasses criteria from the other bridging options to select a primary producer.

Given the availability of several bridging options, the goal of this study is to evaluate the panel's proposed solution against three potential alternatives. To do so, four groups of primary producer proxies are identified, each corresponding to one of the four bridging options described above. After selecting the primary producer proxies for each of the four bridging options, key demographic indicators of interest, such as their age, primary occupation, and sex are compared to assess how estimates vary depending on how one operationalizes primary producers.

## 2. Methods

### 2.1 Data

Data for this study come from the 2015 COA Content Test and the 2016 COA Electronic Data Reporting Tests. The majority of the 2015 COA Content Test data was collected via mail, but some data were also collected online and with the use of computer assisted telephone interviewing (CATI). Given that the primary interest of the content test was to evaluate how changes to the survey questionnaire affected responses, data retrieved via CATI were excluded from these analyses. Data collected with the responsive 2016 web instrument were used in place of data collected with the 2015 online instrument, which was primarily used to develop and troubleshoot online data collection systems. Subsequent analyses include data from 12,739 operations that were received by mail during the 2015 COA Content Test and 2,452 responses that were received online during the 2016 COA

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<sup>1</sup> In accordance with this recommendation, the term producer will now be used instead of operator for the remainder of this manuscript.

EDR Test. With the exception of age and farming experience, all data used in these analyses are unedited.

**2.1.1 Sampling strategy**

A total of 29,740 operations were contacted by mail for participation in the 2015 Census Content Test. The content test had a final response rate of 63.43%. The sample was not representative of the nation as a whole. Operations that were being sampled in numerous surveys throughout 2016 were excluded from the sampling frame to reduce their response burden. All organic operations, operations on Native American Reservations or that were located in Alaska, DC, Hawaii, and Puerto Rico were excluded from the sample. Furthermore, several high impact operations were also excluded from the sampling frame, as were operations that had complex handling procedures.

With that being said, operations were specifically targeted to ensure that all sections of the questionnaire would be completed for the purposes of testing. A systematic sample was drawn by sorting the sampling frame by key characteristics, such as the state in which the operation was located, the farm type and size, and the value of sales. Although not nationally representative, a diverse set of operations are included in the sample.

Over 16% of the 15,000 operations sampled for the 2016 Electronic Data Reporting Test completed the survey online. The sampling frame consisted of approximately 800,000 operations that had indicated that they had internet access on the 2012 Census of Agriculture or had completed at least one NASS survey online within the previous year. The sampling frame for the EDR Test was also sorted by key characteristics, such as geographic location, farm type, size, and value of sales, so that various operations would be included in the sample.

**2.2 Content Test Questionnaires**

Some differences between the 2015 COA Content Test and 2016 EDR Test questionnaires are worth noting. For one, the content test asked respondents to indicate producers' involvement in ten types of agricultural decisions, including day-to-day, land acquisition or sales, land use or crop, livestock, farm equipment purchases or sales, hiring and managing, accounting/payroll, financial, estate planning, or government agricultural program participation decisions (see Figure 3 below).

4. Was this person involved in these specific decisions as of December 31, 2015? For each person and for each item, mark one.			
	Person 1		Person 1, continued
	1642	1643	1658
a. Day-to-day decisions	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable
	1646	1647	1662
b. Land acquisition or sale decisions including leasing . . . .	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable
	1650	1651	1666
c. Land use and crop decisions including planting, crop spraying, timber harvesting or other, e.g., grazing . . . . .	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable
	1654	1655	1753
d. Livestock decisions including purchases, sales, breeding and pasturing, . . . . .	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Not applicable
			1754
			1755
			1757
			1758
			1759
			1761
			1762
			1763

**Figure 3:** Decision-making questions from the 2015 COA Content Test

Following the 2015 COA Content Test, the decision-making questions were reduced to five items: day-to-day, land use or crop, livestock, financial management, and estate planning decisions. These revisions were implemented in the 2016 COA EDR Test. Only the five questions that were included in both tests are included in subsequent analyses<sup>2</sup>

3. Was this person involved in these specific decisions as of December 31, 2017? For each person and for each item, mark all that apply.				
	Person 1	Person 2	Person 3	Person 4
a. Day-to-day decisions	1642 1 <input type="checkbox"/>	1643 1 <input type="checkbox"/>	1644 1 <input type="checkbox"/>	1645 1 <input type="checkbox"/>
b. Land use and/or crop decisions, including planting, crop spraying, or other, e.g., grazing . . . . .	1650 1 <input type="checkbox"/>	1651 1 <input type="checkbox"/>	1652 1 <input type="checkbox"/>	1653 1 <input type="checkbox"/>
c. Livestock decisions, including purchases, sales, breeding, and pasturing. . . . .	1654 1 <input type="checkbox"/>	1655 1 <input type="checkbox"/>	1656 1 <input type="checkbox"/>	1657 1 <input type="checkbox"/>
d. Record keeping and/or financial management. . . . .	1776 1 <input type="checkbox"/>	1777 1 <input type="checkbox"/>	1778 1 <input type="checkbox"/>	1779 1 <input type="checkbox"/>
e. Estate planning or succession planning . . . . .	1757 1 <input type="checkbox"/>	1758 1 <input type="checkbox"/>	1759 1 <input type="checkbox"/>	1760 1 <input type="checkbox"/>

**Figure 4:** Decision-making questions from the 2016 COA EDR Test

Furthermore, in the content test, respondents were asked whether the primary occupation of their producers was a) farm or ranch work, b) other work, or c) currently not in the paid workforce, but the final instrument only allowed respondents to report “farm or ranch work” and “work other than farming or ranching”. For consistency-sake, content test respondents who indicated that the occupation of their producers was “currently not in the paid workforce” were combined with those who reported “other work”.

### 2.3 Four Bridging Options

The analyses presented in this study identify four groups of primary producer proxies to help address the concerns that emerged from revisions to the operator characteristics section of the 2012 census form. These four bridging options are assessed by examining the age, sex, and primary occupation of primary producer proxies, demographic characteristics of primary interest to members of the agriculture industry, policy-makers, and the general public. However, it should be noted that the intention of these analyses is to compare estimates derived from these bridging options to one another, not to extrapolate to the nation as a whole because the data are not nationally representative.

The first bridging option is the First-Person Proxy, and most closely mimics how the principal operator was captured in previous COAs, since respondents were previously asked to designate their principal operator in the first column of the demographics table. This bridging option simply summarizes the information provided for the producer listed in the first column of the demographics table of the personal characteristics section of the form. Using people listed in the first column as primary producer proxies is a reasonable approach since the order in which producers were listed is related to receiving the principal producer designation ( $\chi^2 = 4,093; p < 0.001$ ). Producers listed first received the principal producer designation at the highest rate (90%), while only 31% of those listed fourth were principal producers.

The second bridging option is referred to as the Ordered Role Proxy. Primary producers are identified based on their role or function on the operation and, if multiple primary producers are

<sup>2</sup> Results from cognitive interviews indicated that the accounting/payroll and financial decisions survey items measured the same types of behaviors. Analyses in this study use the financial decisions survey item from the 2015 Content Test because the wording of the question more closely matches the financial management decisions item used in the 2016 Electronic Data Reporting Test.

reported, also prioritizes where producers are reported on the demographics table as done in previous COAs. Selecting primary producers based on their role or function on the operation, as opposed to using the principal operator label, which is open to multiple interpretations, was one of the key recommendations of the Expert Panel on Statistics on Women and Beginning Farmers in the USDA Census of Agriculture. To select the proxies for the Ordered Role Proxy bridging option, producers were first ranked in descending order by the number of decisions in which they were involved, followed by the number of days they worked off the farm in ascending order, and finally by the column in which they were reported in the demographics table in ascending order. If producers were involved in an equal number of decisions, then the person working fewer days off the farm was selected as the primary producer for the operation. If producers had equal levels of decision-making involvement and worked off the farm an equal number of days, then the producer listed earlier in the demographics table (e.g. first column instead of second) was selected as the primary producer, which is consistent with the fact that the order in which one is listed in the demographics table is related to receiving the principal producer designation. Decision-making involvement ( $\chi^2 = 2,868$ ;  $p < 0.001$ ) and the number of days worked off the farm ( $\chi^2 = 64.76$ ;  $p < 0.001$ ) were also significantly related to being listed as principal producers.

The third bridging option is referred to as the Random Role Proxy. This bridging option is a variant of the Ordered Role Proxy, and strictly follows the recommended algorithm of the Expert Panel on the Publication of Farm Operator Demographics. The Random Role Proxy prioritizes decision-making involvement and the number of days worked off the farm in the same manner as the Ordered Role Proxy bridging option. However, if producers had equal levels of decision-making involvement and worked off the operation for the same number of days, one is chosen at random thereby giving them an equal chance of serving as the primary producer of the establishment, as recommended.

Finally, the fourth bridging option is known as the Propensity Proxy and incorporates criteria of the other three bridging options. When operations reported multiple producers on the COA form, proxies for this bridging option are selected using a modeling approach. To select primary producers, principal producer status was regressed on a series of covariates to identify the producer with the highest probability of receiving the principal producer designation. A logistic regression model was estimated to predict whether or not someone received the principal producer designation using three sets of covariates: 1) Demographic Characteristics (age in years, sex, race, spousal status, and whether the person resided on the operation), 2) Farm-Related Characteristics (farming experience in years, retirement status, primary occupation, days worked off the farm, decision-making involvement, and whether one served as a hired manager), and 3) Survey Characteristics (the order in which the person was reported in the demographics table and whether they completed the form).

Older producers ( $b = 0.01$ ,  $p < 0.0001$ ) and producers who have more farming experience ( $b = 0.01$ ,  $p < 0.0001$ ) were more likely to receive the principal producer designation than younger and less experienced producers. Female producers were less likely to be listed as principal producers than their male counterparts ( $b = -0.15$ ,  $p < 0.0001$ ). Spouses of principal producers were more likely to be listed as principal producers than non-spouses ( $b = 0.30$ ,  $p < 0.0001$ ). Not surprisingly, producers whose primary occupation is farm or ranch work ( $b = 0.13$ ,  $p < 0.0001$ ), who are involved in a higher number of agricultural decisions ( $b = 0.40$ ,  $p < 0.0001$ ), and who make day-to-day decisions ( $b = 0.19$ ,  $p < 0.0001$ ) had a higher likelihood of receiving the principal producer designation. Lastly, survey characteristics also significantly predicted the likelihood of receiving the principal producer designation. Producers who filled out the form ( $b = 0.16$ ,  $p < 0.0001$ ) and who were listed first in the demographic table were more likely to be principal producers than producers listed second ( $b = -0.85$ ,  $p < 0.0001$ ), third ( $b = -0.99$ ,  $p < 0.0001$ ), or fourth ( $b = -1.13$ ,  $p < 0.0001$ ).

With the use of this regression model (full results available in Appendix A), primary producer proxies were selected for the operations. If only one producer was reported for a given operation, that person was selected as the proxy for the primary producer by default. However, if multiple producers were listed in the demographics table of the personal characteristics section, the logistic

regression model was used to identify the producer with the highest predicted probability of receiving the principal producer designation. The modeling approach was designed as compromise between the other bridging options because it takes the order in which producers appear on the form and their role within the operation into account when selecting proxies to serve as the primary producers for the establishments.

### 3. Results

#### 3.1 Perceptions of Primary Producers

Primary producer proxies are first compared using two criteria: the percentage that received the principal producer designation and that were reported in the first column of the demographics table on the census form. In previous COAs, respondents were instructed to report the principal producers in the first column of the demographics table. Examining the percentage of primary producers who are listed in the first column on the COA form gives us a sense of which bridging option best matches how respondents previously reported principal producers on previous COAs.

Table 1 describes the percentage of primary producers who received the principal producer designation and who were reported in the first column of the demographics table. The majority (97%) of primary producers selected using the Propensity Proxy bridging option and all of the proxies identified with the First Person bridging option were reported in the first column of the demographics table. A smaller proportion of the primary producers identified by prioritizing their role on the operation were listed in the first column.

	First Person Proxy		Ordered Role Proxy		Random Role Proxy		Propensity Proxy	
	%	f	%	f	%	f	%	f
Principal Producer	90%	12,861	89%	12,642	87%	12,289	92%	11,100
First Person Listed	100%	14,963	89%	13,352	77%	11,565	97%	11,942

Note: Frequencies for Propensity Proxy are lower because complete case analysis was performed

It is interesting to note that while primary producers selected using the Ordered and Random Role Proxy options were reported in the first column of the demographics table the least, 89% and 87% of these proxies still received the principal producer designation—thereby suggesting that respondents perceived the majority of these proxies to be principal producers. Primary producers identified using the Propensity Score Proxy received the principal producer designation at the highest rate of 92%. Although proxies selected with each bridging option received the principal producer designation at high rates, there was a significant association between the bridging options and the principal producer status of the primary producers identified ( $\chi^2 = 203.39$ ;  $p < 0.001$ ).

#### 3.2 Age of Primary Producers

The ages of the primary producers selected with the four bridging options are compared using three criteria: their average age, the percentage of young farmers, and the percentage of new farmers. These indicators of age are important to policy makers and members of the agricultural community because they indicate whether primary producers are being replaced by younger cohorts of producers.

Although analyses indicated that the average age across these groups differed from one another ( $f = 10.89$ ,  $p < 0.0001$ ), the range in the average age across the four bridging options is less than one year (see Table 2 below). Nevertheless, subsequent analyses revealed that the average ages for the First Person Proxy (62.03) and the Ordered Role Proxy (61.86) groups, were higher than the Random Role Proxy (61.45) and Propensity Proxy (61.30) groups at the 0.05 level<sup>3</sup>.

<sup>3</sup> Results are consistent for both the tukey and bonferroni corrections to the type I error rates.

	First Person Proxy		Ordered Role Proxy		Random Role Proxy		Propensity Proxy	
	Indicator	f	Indicator	f	Indicator	f	Indicator	f
Average Age <sup>1</sup>	62.03 <sup>a</sup>	14,450	61.86 <sup>a</sup>	14,445	61.45 <sup>b</sup>	14,428	61.30 <sup>b</sup>	12,258
Young Farmers	2.10%	304	2.30%	332	2.77%	399	2.34%	287
New Farmers	15.51%	2,107	15.69%	2,130	16.30%	2,209	16.02%	1,914

Note: Means sharing a superscript do not differ from one another at the .05 alpha level<sup>1</sup>

Young farmers are defined as producers who are younger than 35 years of age, while new farmers are producers who have been operating an agricultural establishment for 10 years or less. The percentage of young farmers was associated with the bridging options ( $\chi^2 = 14.47$ ;  $p < 0.01$ ), despite there being less than a 1 percentage point difference between all groups. The highest percentage of young farmers were present among the Random Role Proxy producers (2.77%), while the lowest percentage were found among primary producers selected using the First Person Proxy (2.10%). No statistically significant differences in the percentage of new farmers were found between the four bridging options ( $\chi^2 = 3.78$ ; *ns*).

### 3.2 Occupation of Primary Producers

The primary occupation of the primary producer proxies did not differ across the four bridging options ( $\chi^2 = 5.73$ ; *ns*). The percentage of primary producers whose reported primary occupation was farming or ranch work ranged from 41% (First Person Proxy) to 43% (Ordered Role Proxy). The percentage of primary producers who are engaged in other types work was also similar across the four groups (see Table 3 below).

Bridging Option	Farming or Ranching	Other Work	Total
First Person Proxy	41%	59%	100%
	5,908	8,445	14,353
Ordered Role Proxy	43%	57%	100%
	6,108	8,246	14,354
Random Role Proxy	42%	58%	100%
	6,014	8,328	14,342
Propensity Proxy	42%	58%	100%
	5,139	7,124	12,263

Note: Percentages may not sum to 100% due to rounding

### 3.3 Sex of Primary Producers

The sex of primary producers was significantly associated with the four bridging options ( $\chi^2 = 1,147.12$ ;  $p < 0.0001$ ). The percentage of female primary producers was lowest for the First Person Proxy (13%) and Propensity Proxy (14%) bridging options (see Table 4 below). This is not surprising given that the regression analyses revealed that women were less likely to receive the principal producer designation than men. Furthermore, the Expert Panel on Statistics on Women and Beginning Farmers in the USDA Census of Agriculture noted that there was a tendency for respondents to report male producers first in the demographics table. A notably higher percentage

of women were found when primary producers were defined by their role within the operation with the Ordered Role Proxy (20%) and Random Role Proxy (27%) bridging options.

Bridging Option	Female	Male	Total
First Person Proxy	13%	87%	100%
	1,878	12,651	14,529
Ordered Role Proxy	20%	80%	100%
	2,885	11,634	14,519
Random Role Proxy	27%	73%	100%
	3,869	10,617	14,486
Propensity Proxy	14%	86%	100%
	1,693	10,598	12,291

Note: Percentages may not sum to 100% due to rounding

#### 4. Discussion and Conclusion

Expert panels are commonly called upon to provide technical reviews of materials, procedures, and policies within the federal government. As a result of criticism of the Census of Agriculture's underrepresentation of female and younger principal producers in 2012, the National Agricultural Statistics Service sought recommendations from expert panels on how to best collect and publish information on the demographics of farm producers, which will more fully capture the participation of women and young farmers.

Resultant changes in how we define the producers who represent agricultural establishments and how information from them should be collected led to practical issues related to how to continue to analyze and publish demographic information on farmers and ranchers across the United States. This study attempts to address these issues by assessing four approaches to bridge the data series and continue to examine trends in agricultural producer demographics over time.

One of these solutions mimics how producer demographics were collected in the past by relying exclusively on the information provided for the producer listed in the first column of the form, while two other options adhere to the recommendations of the expert panels to define producers based on their role or function within the operation. A fourth potential solution, takes an intermediate approach by accounting for where producers are reported on the form and how much involvement they have on the operation when identifying primary producers.

The four options provide relatively comparable estimates for the age and occupation of primary producers of agricultural establishments. Statistically significant differences emerged in two of the three indicators of age of the primary producer proxies. However, the effect sizes are so small that the groups appear to be substantively similar to one another. No differences were found in their reported occupations.

The representation of women among primary producers differed among the four bridging options from both a statistical and practical standpoint. When one adopts a traditional or intermediate approach to operationalizing primary producers, the proportion of female primary producers on agricultural establishments are comparable to estimates from 2012, which were heavily criticized as

likely underrepresenting the roles of female producers. However, when producers are explicitly selected based on their role within the operation, as recommended by the expert panels, females are represented to a much greater extent among primary producers. This suggests that women may have a more active role in leadership on agricultural operations than may have been indicated by prior COA estimates.

Interestingly, in deciding among the four bridging options, there is an inherent tension over whether the accuracy of agricultural producer demographics or the ability to track differences in producer demographics over time should be prioritized. In other words, should the bridging option that allows us to best assess changes in producer demographics over time be used, even if there is ample evidence to suggest that the estimates being compared are biased? Or should the bridging option that best captures the demographics of agricultural producers be used, knowing that any comparisons made with past estimates will be biased? In accordance with the recommendations of the Expert Panel on the Publication of Farm Operator Demographics, NASS will publish primary producer demographics using the Random Role Proxy in the upcoming 2017 Census of Agriculture.

This study highlights the complexity of making changes to survey questionnaires in an operational environment and provides a blueprint of how to address issues when said changes may interrupt a data series. When dealing with such issues, various solutions may be available. In our particular setting, the landscape of farm producer demographics varies substantially according to one's operational definition of a primary producer. Therefore, solutions should not be implemented without careful planning and deliberation or we run the risk of mischaracterizing the roles of the populations we serve.

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### Appendix

#### A. Logistic Regression Model Predicting Principal Producer Status (n=17,137)

Variable	B	SE	P Value	OR
Age (years)	0.01*	0.002	.001	1.01
Female (Yes=1)	-0.15*	0.030	.001	0.74
Spouse (Yes=1)	0.30*	0.029	.001	1.81
Reside on Farm	-0.03	0.029	.254	0.94
Years Farming	0.01*	0.002	.001	1.01
Retired (Yes=1)	-0.03	0.039	.371	0.93
Race				
White (ref)	-	-	-	-
Black	-0.02	0.129	.906	0.97
Other	-0.05	0.095	.603	0.91
Days Worked Off Farm				
No Days (ref)	-	-	-	-
Up to 50 Days	-0.08	0.044	.055	0.85
Up to 100 Days	0.03	0.061	.613	1.06
Up to 200 Days	-0.04	0.044	.407	0.93
200+ Days	-0.00	0.031	.943	1.00
Primary Occupation				
Farming (ref)	-	-	-	-
Other Work	-0.13*	0.030	.001	0.77
Number of Decisions	0.40*	0.019	.001	1.49
Day-to-Day Decisions (Yes=1)	0.19*	0.043	.001	1.45
Hired Manager (Yes=1)	-0.12*	0.047	.013	0.79
Filled Out Form (Yes=1)	0.16*	0.029	.001	1.37
Order on Form				
Person 1 (ref)	-	-	-	-
Person 2	-0.85*	0.036	.001	0.18
Person 3	-0.99*	0.055	.001	0.14
Person 4	-1.13*	0.086	.001	0.11
(Intercept)	-3.32*	0.289	.001	-

Model  $\chi^2 = 4063.23$ ,  $df = 22$ ,  $p < .0001$