Agroforest Syst (2025) 99:34
https://doi.org/10.1007/s10457-024-01096-2

Agroforestry across the United States: Results of the 2022 Census of Agriculture

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Received: 12 July 2024 / Accepted: 10 December 2024 / Published online: 1 February 2025

Abstract Agroforestry offers producers climate mitigation and adaptation benefits and the opportunity to diversify income and enhance ecosystem services. Though these benefits are well-researched, few studies document agroforestry implementation through time in the United States using consistent national data sources. To fill this knowledge gap, we investigated changes in the number of farm operations with agroforestry across the United States using data from the 2017 and 2022 United States Census of Agriculture. Through this analysis, we showed that the number of farm operations with agroforestry increased by 6% nationally between 2017 (30,853) and 2022 (32,717). States with the highest percent of total farms reporting at least one type of agroforestry were Vermont (7.8%), Maine (6.0%), and New Hampshire (5.6%), while states with the lowest percent were Arizona (0.3%), Utah (0.4%), and North Dakota (0.4%). States on the eastern half of the country tended to see increases in the number of farm operations with agroforestry between census years, while states on the western half of the country saw the largest decreases. Reasons for these changes are complex and require additional analysis. Additionally, we identified potential factors that may decrease the accuracy of agroforestry census data, along with recommendations on how to improve overall data quality going forward. We outlined how national agroforestry census data can inform decision-making related to farm policies, funding, programs, research, and extension delivery. With an online supplement, we also provided detailed maps of the extent of agroforestry in all 50 states.

Keywords Windbreak · Silvopasture · Riparian forest buffer · Alley cropping · Forest farming · Survey

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10457-024-01096-2.

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Introduction

Agroforestry practices offer climate mitigation and adaptation benefits, while providing producers with the opportunity to diversify income and enhance ecosystem services (McElwee et al. 2020; Nabuurs et al. 2022; Schoeneberger et al. 2017). In the United States, agroforestry is commonly defined as a suite of land management practices that intentionally integrate woody plants (trees, shrubs, vines, etc.) with crop and/or animal production systems. Due to numerous economic, ecological, and social benefits of these practices, there is growing interest in quantifying the number of agroforestry systems across the landscape and identifying where future systems are most likely to occur. This type of data is critical for the following reasons:

1. Identifying changes in agroforestry practice implementation over time.
2. Matching financial and technical assistance to support future agroforestry demand.
3. Identifying agroforestry “hot spots” for future research.
4. Refining sampling frames for follow-up, content-specific surveys.
5. Informing decision-making related to past and future farm policies, funding, programs, research, and extension delivery.
6. Estimating ecosystem services from agroforestry practices (e.g., carbon, nutrient and pollution remediation, pollinator services).

However, national-scale data sources for the extent of agroforestry across the United States are limited and are generally not repeated or available across multiple points in time. To date, the most comprehensive dataset for agroforestry extent in the United States comes from the Census of Agriculture (COA), administered by the USDA National Agricultural Statistics Service (NASS) (Smith et al. 2022a; USDA NASS 2019a). The COA reports on all farm operations from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year (USDA NASS 2019a). The Yes/No agroforestry question, introduced in the 2017 COA, asked producers across the country whether they have any one of the five most commonly implemented agroforestry practices in the United States. These practices were alley cropping, silvopasture, forest farming, riparian forest buffers and windbreaks. Definitions for each of these practices can be found in USDA NASS COA Report Form Guide (USDA NASS 2017). Data from the 2017 COA showed that there were 30,853 farm operations reporting agroforestry across the United States (USDA NASS 2019a).

While data from the 2017 COA provided the first national-level estimates for the extent of agroforestry across the United States, it represents a single point in time. NASS included the same agroforestry question in the 2022 COA, allowing for the first national-level trend analysis for agroforestry extent in the United States. Using raw data from this comprehensive national dataset, the objectives of this study are to: (1) identify where producers reported using agroforestry across the United States, (2) identify where agroforestry adoption increased or decreased across multiple regional scales, (3) discuss potential factors that may decrease the accuracy of agroforestry census data, (4) provide recommendations on how to improve overall data quality going forward, and (5) provide detailed maps for all 50 states in the country showing regional nuances for the number of farm operations using agroforestry between census years (Online Resource 1).

Methods

The 2022 COA was released in February of 2024. Census results were downloaded via the Quick Stats database available on the USDA NASS website (USDA NASS 2024d). The Quick Stats database is a web-based application, which gives the user the ability to query all census results at the state and county level. To determine the number of farm operations who responded “Yes” to the agroforestry question, we used the following query string: Census > Economics > Farm and Land and Assets > Practices > Area > Data Item > Practices, Alley Cropping and Silvopasture-Number of Operations > County > 2022. The total number of farms per county was queried using the following string: Census > Economics > Farm and Land and Assets > Farm Operations > Operations > Farm Operations-Number of Operations > Total > County > 2022.

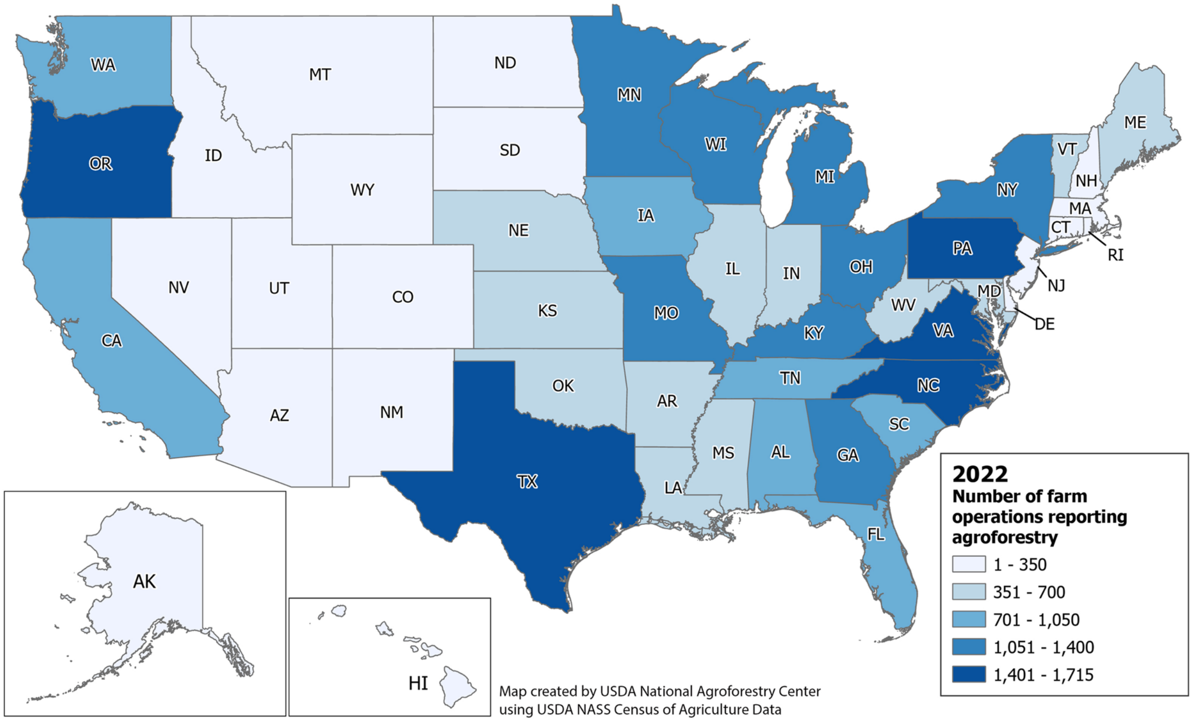

Fig. 1 Number of farm operations by state reporting at least one agroforestry practice in the 2022 United States Census of Agriculture. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2024a)

County-level data were exported to Microsoft Excel (Microsoft 365 MSO Ver. 2401, 64-bit). To create maps, the Excel tables were imported into ArcGIS Pro version 3.2 and joined to a United States county boundary layer from the United States Census Bureau Federal Information Processing System (FIPS) county codes (U.S. Census Bureau 2022) as the common field using the Join Fields tool in ArcGIS Pro (ESRI 2023). A second GIS dataset with 2017 COA numbers was then joined from a previously published GIS county-level layer (Kellerman 2023), which allowed for comparison between time periods. Counties for this study were based on NASS data within the Quick Stats database, which has 3,078 total counties with at least one farm operation in 2022 as well as 2017. This value is lower than the Census Bureau number of counties for the United States (3143) due to NASS modifications to some states (USDA NASS 2024c, d). The county-level output maps reflect these changes.

Results

According to the 2022 COA, there were 32,717 farm operations in the United States practicing agroforestry. This represents 1.7% of all farm operations in the United States (1,900,487). While this value may seem small, it is important to recognize the diversity of agricultural systems used by producers across the United States. For example, the 2022 COA showed that there were 17,048 farms that were certified organic (0.9%), 35,331 farms that produced berries (1.9%), 60,809 farms with hogs and pigs (3.2%) and 110,544 farms with land in orchards (5.8%) (USDA NASS 2024a). These examples help provide context and show that the percent of farms in any agricultural practice is relative.

The states with the highest number of farm operations reporting agroforestry were Texas (TX, 1715), Pennsylvania (PA, 1610), and Virginia (VA, 1534). The states with the fewest farm operations with agroforestry were Nevada (NV, 18), Delaware (DE,

Table 1 Total number of farm operations in the United States reporting agroforestry by state based on the 2022 and 2017 United States Census of Agriculture (USDA NASS 2019a, 2024a)

State	Total number of farms in 2017	Total number of farms in 2022	Number of farms reporting at least one agroforestry practice in 2017	Number of farms reporting at least one agroforestry practice in 2022	Percentage of farms reporting at least one agroforestry practice in 2017	Percentage of farms reporting at least one agroforestry practice in 2022	Change in the proportion of farms reporting at least one agroforestry practice from 2017 to 2022
Alabama (AL)	40,592	37,362	635	736	1.56%	1.97%	0.41%
Alaska (AK)	990	1173	35	44	3.54%	3.75%	0.22%
Arizona (AZ)	19,086	16,710	42	47	0.22%	0.28%	0.06%
Arkansas (AR)	42,625	37,756	585	686	1.37%	1.82%	0.44%
California (CA)	70,521	63,134	1064	974	1.51%	1.54%	0.03%
Colorado (CO)	38,893	36,056	361	329	0.93%	0.91%	−0.02%
Connecticut (CT)	5521	5058	188	215	3.41%	4.25%	0.85%
Delaware (DE)	2302	2158	48	28	2.09%	1.30%	−0.79%
Florida (FL)	47,590	44,703	803	804	1.69%	1.80%	0.11%
Georgia (GA)	42,439	39,264	969	1087	2.28%	2.77%	0.49%
Hawaii (HI)	7328	6569	347	307	4.74%	4.67%	−0.06%
Idaho (ID)	24,996	22,877	317	304	1.27%	1.33%	0.06%
Illinois (IL)	72,651	71,123	604	623	0.83%	0.88%	0.04%
Indiana (IN)	56,649	53,599	594	605	1.05%	1.13%	0.08%
Iowa (IA)	86,104	86,911	822	787	0.95%	0.91%	−0.05%
Kansas (KS)	58,569	55,734	438	519	0.75%	0.93%	0.18%
Kentucky (KY)	75,966	69,425	1028	1102	1.35%	1.59%	0.23%
Louisiana (LA)	27,386	25,006	349	359	1.27%	1.44%	0.16%
Maine (ME)	7600	7036	362	424	4.76%	6.03%	1.26%
Maryland (MD)	12,429	12,550	473	513	3.81%	4.09%	0.28%
Massachusetts (MA)	7241	7083	299	271	4.13%	3.83%	−0.30%
Michigan (MI)	47,641	45,581	957	1114	2.01%	2.44%	0.44%
Minnesota (MN)	68,822	65,531	1011	1082	1.47%	1.65%	0.18%
Mississippi (MS)	34,988	31,290	542	571	1.55%	1.82%	0.28%
Missouri (MO)	95,320	87,887	1311	1383	1.38%	1.57%	0.20%
Montana (MT)	27,048	24,266	298	267	1.10%	1.10%	0.00%
Nebraska (NE)	46,332	44,479	458	360	0.99%	0.81%	−0.18%
Nevada (NV)	3423	3122	11	18	0.32%	0.58%	0.26%
New Hampshire (NH)	4123	3949	170	223	4.12%	5.65%	1.52%
New Jersey (NJ)	9883	9998	263	282	2.66%	2.82%	0.16%
New Mexico (NM)	25,044	20,976	201	153	0.80%	0.73%	−0.07%
New York (NY)	33,438	30,650	1187	1350	3.55%	4.40%	0.85%
North Carolina (NC)	46,418	42,817	1162	1416	2.50%	3.31%	0.80%

Table 1 (continued)

State	Total number of farms in 2017	Total number of farms in 2022	Number of farms reporting at least one agroforestry practice in 2017	Number of farms reporting at least one agroforestry practice in 2022	Percentage of farms reporting at least one agroforestry practice in 2017	Percentage of farms reporting at least one agroforestry practice in 2022	Change in the proportion of farms reporting at least one agroforestry practice from 2017 to 2022
North Dakota (ND)	26,364	25,068	155	111	0.59%	0.44%	−0.15%
Ohio (OH)	77,805	76,009	1156	1316	1.49%	1.73%	0.25%
Oklahoma (OK)	78,531	70,378	514	652	0.65%	0.93%	0.27%
Oregon (OR)	37,616	35,547	1467	1427	3.90%	4.01%	0.11%
Pennsylvania (PA)	53,157	49,053	1657	1610	3.12%	3.28%	0.16%
Rhode Island (RI)	1043	1054	37	52	3.55%	4.93%	1.39%
South Carolina (SC)	24,791	22,633	667	721	2.69%	3.19%	0.50%
South Dakota (SD)	29,968	28,299	252	240	0.84%	0.85%	0.01%
Tennessee (TN)	69,983	63,105	938	1015	1.34%	1.61%	0.27%
Texas (TX)	248,416	230,662	1347	1715	0.54%	0.74%	0.20%
Utah (UT)	18,409	17,386	61	68	0.33%	0.39%	0.06%
Vermont (VT)	6808	6537	492	507	7.23%	7.76%	0.53%
Virginia (VA)	43,225	38,995	1526	1534	3.53%	3.93%	0.40%
Washington (WA)	35,793	32,076	1075	1041	3.00%	3.25%	0.24%
West Virginia (WV)	23,622	22,787	384	377	1.63%	1.65%	0.03%
Wisconsin (WI)	64,793	58,521	1120	1286	1.73%	2.20%	0.47%
Wyoming (WY)	11,938	10,544	71	62	0.59%	0.59%	−0.01%
Total	2,042,220	1,900,487	30,853	32,717			

28), and Alaska (AK, 44) (Fig. 1, Table 1, Online Resource 1).

The states with the highest percent of total farms reporting at least one type of agroforestry were Vermont (VT, 7.8%), Maine (ME, 6.0%), and New Hampshire (NH, 5.6%). The states with the lowest percent of total farms reporting agroforestry were Arizona (AZ, 0.3%), Utah (UT, 0.4%), and North Dakota (ND, 0.4%) (Fig. 2, Table 1, Online Resource 1).

Of the 3078 counties in the United States that reported at least one farm operation, 2611 reported an agroforestry practice (85%) (Fig. 3). Hawaii County, Hawaii (HI) had the highest number of farm operations reporting agroforestry with 178 farms. Seven of the top 10 counties with the highest number of farms reporting agroforestry were in Oregon (OR), all of which reported results greater than 78 farm operations per county.

Across the United States, there were 24 counties that reported over 10% of farms using agroforestry. Swain County, North Carolina (NC) reported the highest percent with 12 of 70 farms in the county (17.1%). County-level data allowed for the opportunity to identify hot spots within specific states. For example, there were some clusters of counties with a higher percentage of farms reporting agroforestry than adjacent counties in western North Carolina

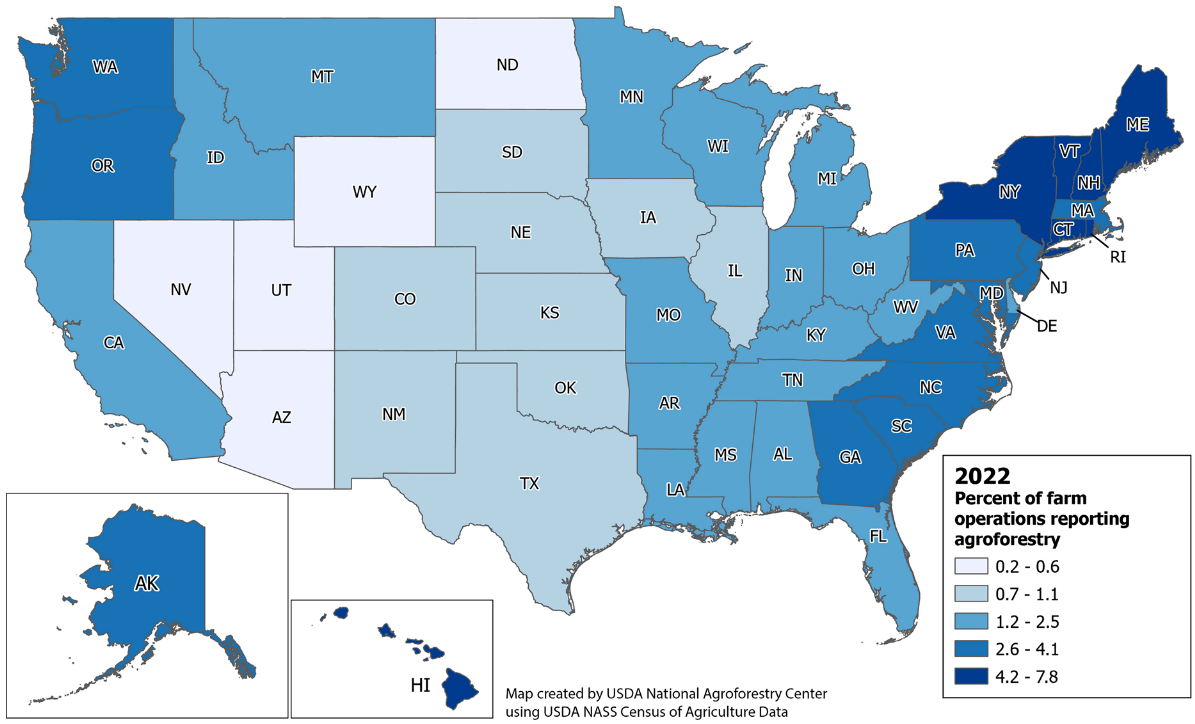

Fig. 2 Percent of farm operations by state reporting at least one agroforestry practice in the 2022 United States Census of Agriculture. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2024a)

(NC), southern Arkansas (AR), and eastern Texas (TX) (Fig. 4).

Agroforestry trends between 2017 and 2022

Between census years, agroforestry implementation increased by 6%, from 30,853 farm operations in 2017 to 32,717 farm operations in 2022. A comparative analysis showed that some states saw an increase in the number of farm operations reporting agroforestry, while other states saw a decrease (Fig. 5). For example, Nevada (NV) saw an increase of 63.6% for the number of farms reporting agroforestry, though the numbers are relatively small (11–18). Texas (TX) saw an increase of 27.3% (1347–1715). Overall, 33 states showed an increase in farm operations reporting agroforestry and 17 states showed a decrease from 2017. For example, Delaware (DE) decreased by 41.7% (48–28 farm operations) and North Dakota decreased by 28.4% (155–111 farm operations) (Table 1).

Of the 3078 counties in the United States with at least one farm, 1367 (44%) had an increase of farm operations reporting agroforestry, 1280 (42%) reported a decrease, 159 (5%) stayed the same, and 273 (9%) had no reports of agroforestry in either census year. Changes in counties reporting agroforestry versus not reporting agroforestry were similar between census years (Fig. 6). There were 191 counties that did not report any agroforestry in 2017 but reported at least one farm with agroforestry in 2022. In contrast, there were 195 counties that reported agroforestry in 2017 but did not report agroforestry in 2022.

When comparing numbers between the 2017 and 2022 COAs, it is important to consider that the total number of farms in the United States also changed. In 2017 there were 2,042,220 farms compared to 1,900,487 in 2022 (−7%). The change in proportion of farm operations reporting agroforestry between 2017 and 2022 reflects the change in the percent of farms reporting agroforestry and the change in the total number of farms for the two time

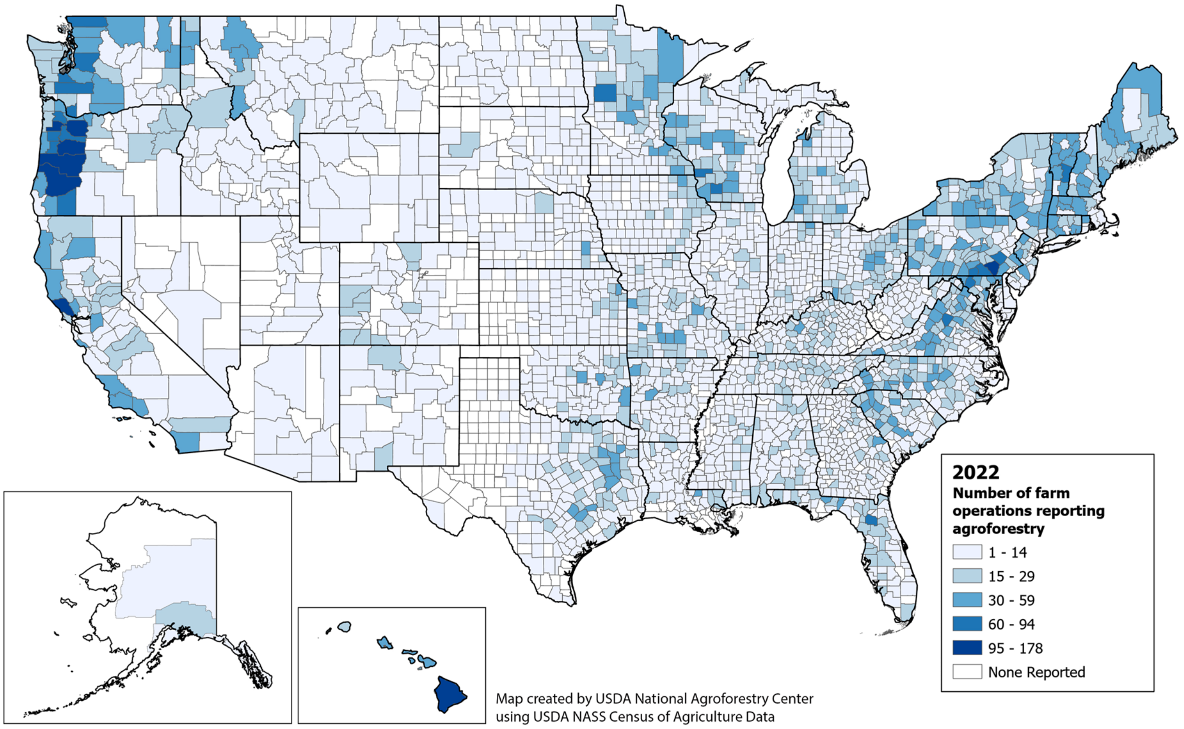

Fig. 3 Number of farm operations by county reporting at least one agroforestry practice in the 2022 United States Census of Agriculture. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2024a)

periods. These values are shown in Figs. 7 and 8, as well as the last column of Table 1. For example, in the state of New Hampshire (NH), 4.1% of farms reported agroforestry in 2017 and 5.6% in 2022. The 1.5% addition incorporates an increase in the number of farms reporting agroforestry (170–223) and a decrease in the total number of farms in the state (4123–3949) from 2017 to 2022. A county-level example from Swain County in western North Carolina (NC) shows a 15.1% percentage point change in the proportion of farm operations reporting agroforestry, with 2.0% of farms reporting agroforestry in 2017 and 17.1% in 2022. While there was an increase from 2 to 12 farms using agroforestry, there were also 29 fewer total farms in Swain County in 2022 (99–70). The change in proportion of farm operations illustrates areas of increase or decrease while accounting for the changes in total farm count in the area. For example, when not accounting for changes in farm counts between census years, 17 states saw a decrease in the number of farm operations reporting agroforestry. This value changes to 10 states when factoring in changes in overall farm number.

Discussion

Between census years, there was a 6% rise in the number of farm operations reporting agroforestry use across the United States with an increase of 1864 more farms in 2022 (32,717) than 2017 (30,853). Because agroforestry occurs predominately on private lands in the United States (MacFarland et al. 2017), producers are the ultimate decision makers about agroforestry use, and may be influenced by a number of intrinsic and extrinsic factors that ultimately lead to implementation. Drivers leading to an increase have been investigated in the United States on a regional scale. Some of the key variables leading to an increase include technical assistance (Rhodes et al. 2018; Skelton et al. 2005), financial assistance

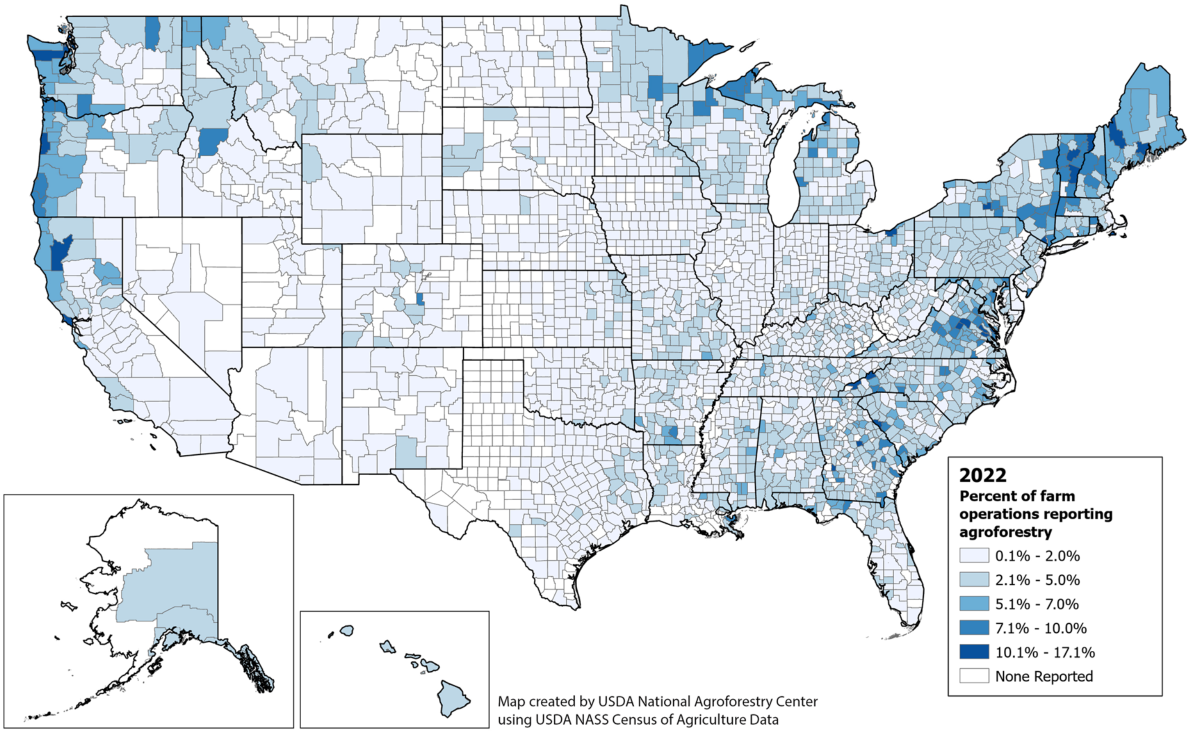

Fig. 4 Percent of farm operations by county reporting at least one agroforestry practice in the 2022 United States Census of Agriculture. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2024a)

(Hardesty et al. 1993; Lynch et al. 2002; Rhodes et al. 2018; Wilkens 2019), and increased understanding of the system as it relates to products, yields, environmental benefits, risks and costs (Sullivan et al. 2004; Trozzo et al. 2019, 2014; Wagner 2008). Additional drivers may also include increased federal program support for agroforestry (USDA FS 2024c; USDA NRCS 2024), newly formed regional agroforestry working groups that interface with producers (USDA FS 2024a), and more support from nonprofits, agencies, and institutions for agroforestry implementation and training. Overall, there is a gap in national scale understanding regarding these potential adoption drivers, which present an important opportunity for additional research. Currently, few inferences can be made as to the underlying drivers that led to an increase in agroforestry use in some regions between census years.

While many states showed an expansion of farm operations reporting agroforestry between census years, some showed a decrease. For instance, the state of Nebraska had a drop of 98 farm operations reporting agroforestry, representing a decrease of 21.4%. The state of Delaware also saw a 42% decrease in the number of farm operations with agroforestry (Table 1). The drivers leading to discontinuation of an agroforestry practice are complex and few studies have investigated this topic in the United States. For example, a recent review of silvopasture adoption literature in the United States found that few regional survey studies reported on reasons for silvopasture discontinuation (Smith et al. 2022b). However, a review of windbreak adoption in the United States found that key drivers for removing windbreaks across the country were (1) poor condition of the trees, (2) age of the trees, (3) conflict between trees and irrigation, farm machinery or farming practices, and (4) windbreak trees competing with crops (Smith et al. 2021). Without additional regional survey studies, few inferences can be made as to the factors influencing producer decision making that led to a decrease in agroforestry use in some regions between

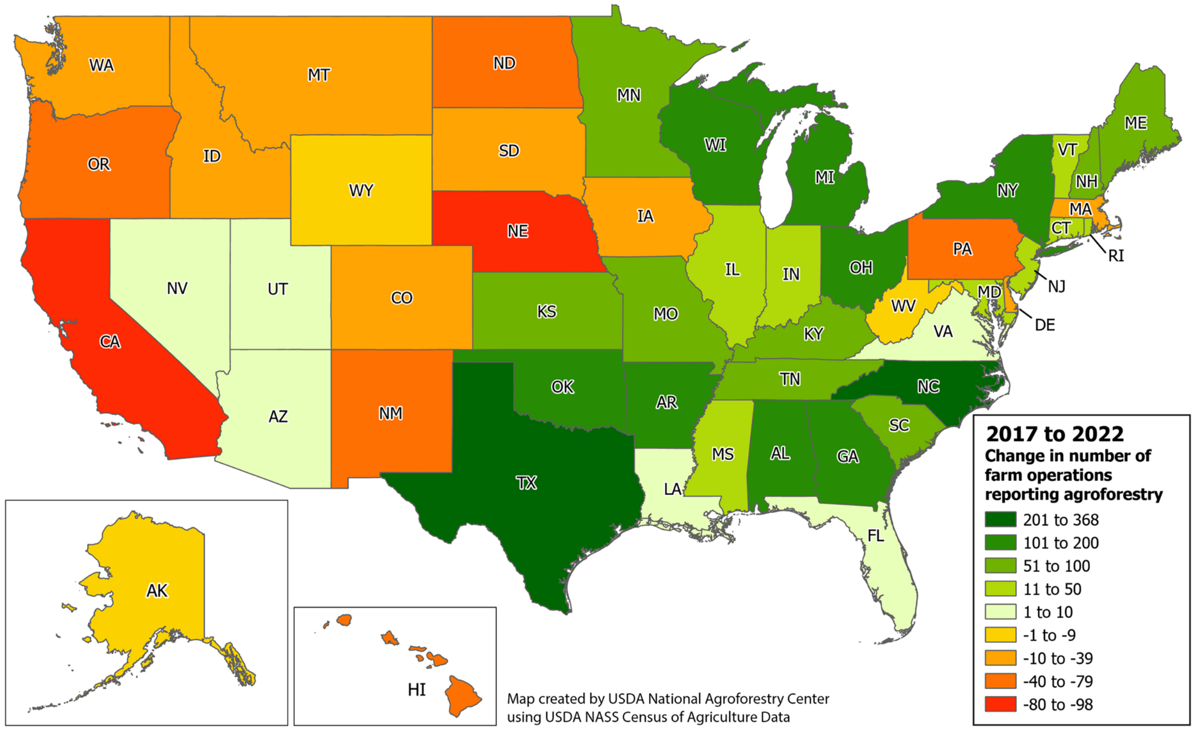

Fig. 5 Change in the number of farm operations reporting at least one agroforestry practice by state between the 2022 and 2017 United States Census of Agriculture reporting periods. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2019a, 2024a)

census years. This represents a key research gap needing further investigation.

Data accuracy

These time series COA data fill an important gap in our understanding of agroforestry extent across the United States and offer the most robust, longitudinal information to assess agroforestry use over time (Smith et al. 2022a). The COA is designed to be a comprehensive representation of agricultural operations in the United States, which include any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold during the census year. A key question to consider is the completeness and accuracy of the data. Completeness and accuracy are essential for effective use of the COA data and NASS applies a robust methodology and implementation strategy to ensure these objectives are met (USDA NASS 2024b). However, factors unique to agroforestry may lead to an over- or undercount of producers reporting agroforestry when filling out the COA or other regional agroforestry surveys (Fig. 9).

Misunderstanding around agroforestry terminology may contribute to an overcount where producers mistakenly assume one of their practices to be agroforestry when in fact it does not meet standard definitions. In the United States, agroforestry is defined as the intentional integration of woody plants (trees, shrubs, vines, etc.) with crop and/or animal production systems to create environmental, economic, or social benefits (USDA 2019). Some producers might consider their farm woodlot, orchard, tree farm, tree plantation, or Christmas tree farm as an agroforestry practice; however, these types of practices generally do not meet this accepted definition unless livestock and or other crops are deliberately integrated. In other cases, it is unclear whether a practice is agroforestry or not (Smith et al. 2022b). For instance, are maple syrup operations agroforestry systems? Do riparian areas count as riparian forest buffers if they

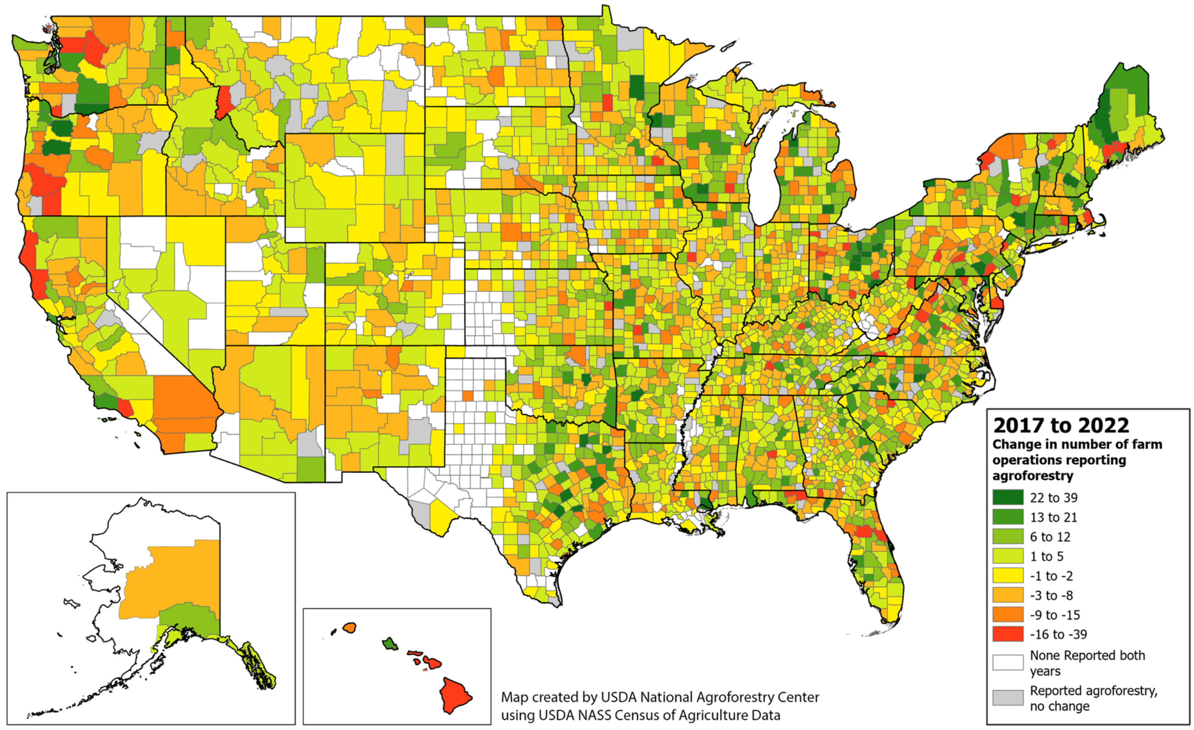

Fig. 6 Change in the number of farm operations reporting at least one agroforestry practice by county between the 2022 and 2017 United States Census of Agriculture reporting periods. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2019a, 2024a)

regenerated naturally but serve the same functional purpose as a planted buffer? These types of unresolved questions can lead to different responses by producers.

Lack of familiarity with agroforestry terminology may also lead to an undercount. The COA question listed five agroforestry practices (alley cropping, silvopasture, forest farming, riparian forest buffers, and windbreaks) although there are other terms used to describe these practices in the United States. For instance, shelterbelt, timberbelt, living snow fence, and vegetated environmental buffer are some of the terms used to describe different types of windbreaks. While definitions for the five listed practices were provided in the COA Report Form Guide (USDA NASS 2019b), this list was not exhaustive, and it is uncertain how many producers referenced this information prior to filling out the agroforestry question. Further, a systematic review of silvopasture adoption in the United States found that confusion exists between woodland grazing and silvopasture, with silvopasture likely being underreported (Smith et al. 2022b). As such, producers may have responded "no" to using agroforestry because they are not familiar with agroforestry terminology.

Another potential reason for an undercount relates to agroforestry practices not covered in the COA question. For example, a hedgerow comprised of trees and shrubs is a distinct agroforestry practice not covered in the COA. Some food forests and other multi-story cropping systems may also be underreported. Further, Indigenous producers may use different terminology to describe agroforestry systems, such as forest gardens, that may not align well with the five broad categories used in the COA, resulting in an undercount of these operations (Armstrong et al. 2023; MacFarland et al. 2017; Rossier and Lake 2014; Wartman et al. 2018). Other Indigenous land practices, such as stewardship of culturally significant plants (Baumflek et al. 2021; Mucioki et al. 2022), Indigenous fire stewardship (Greenler et al. 2024; Lake et al. 2017), cultural and ecological restoration

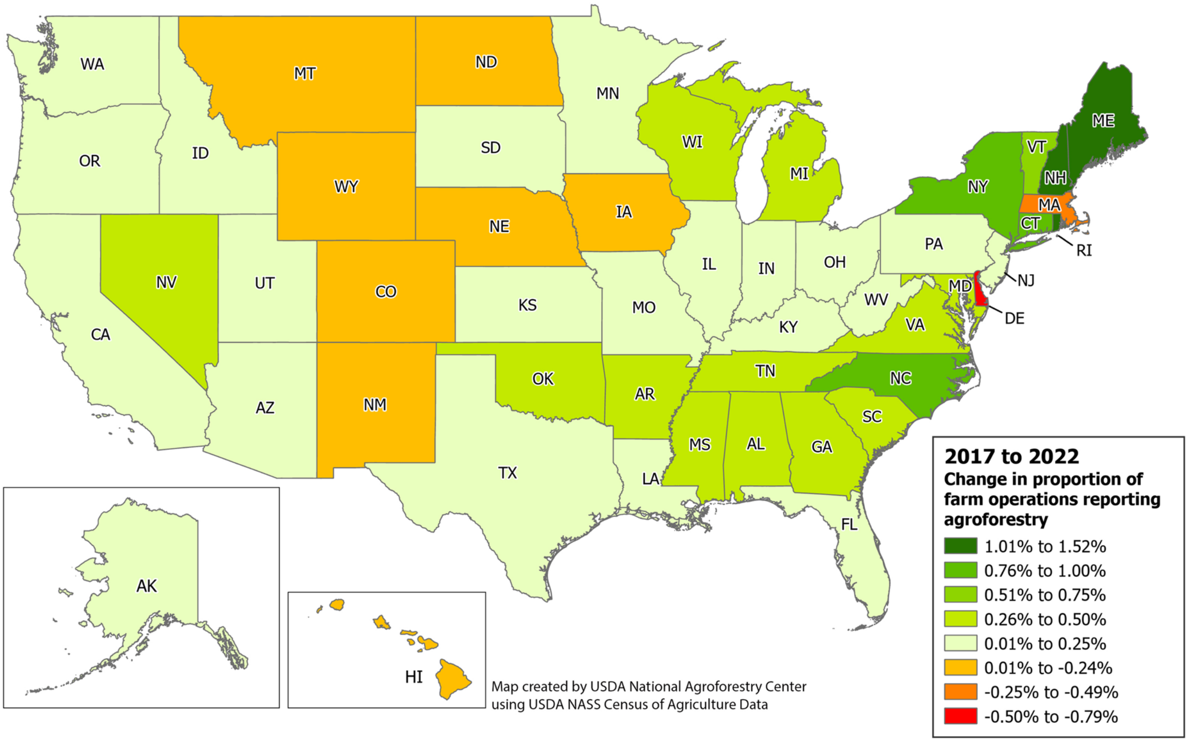

Fig. 7 Change in proportion of farm operations reporting at least one agroforestry practice by state between the 2022 and 2017 United States Census of Agriculture reporting periods. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture and forest farming (USDA NASS 2019a, 2024a)

(Thoreson et al. 2024), and other approaches can be cross walked with agroforestry practice terminology to identify areas of overlap (Lake 2022). Producers using Indigenous approaches that also align with agroforestry terminology may not have answered "yes" to the COA question, potentially resulting in an undercount.

As the COA addresses agricultural activities on farms and ranches, it was not designed to include other land uses. For example, forest farming is often practiced on forested lands and may be underrepresented in the COA. The National Woodland Owners Survey (NWOS) assesses private forest landowners in the United States and has a specific question on whether the operation collected any nontimber forest products (NTFPs) (USDA FS 2024b). NTFPs are any forest products aside from commercially harvested timber that have potential personal or commercial value. Many NTFPs may be grown in forest farming systems. In the 2018 NWOS, harvesting NTFPs was a common activity with over 1,200,000 owners with 4 hectares or more of forest land indicating they have harvested NTFPs on their property (Butler et al. 2021). Some of these forest owners may be harvesting NTFPs from a forest farming system, yet may not have received a COA.

Looking to the Future

The trend data from the COA provides a snapshot of agroforestry extent in the United States and offers a foundation to build upon. Key to building upon this foundation is improving agroforestry extent data (Smith et al. 2022a). Many of these strategies are also applicable to regions outside of the United States and include:

1. Increasing awareness of a country's Census of Agriculture to producers with agroforestry.

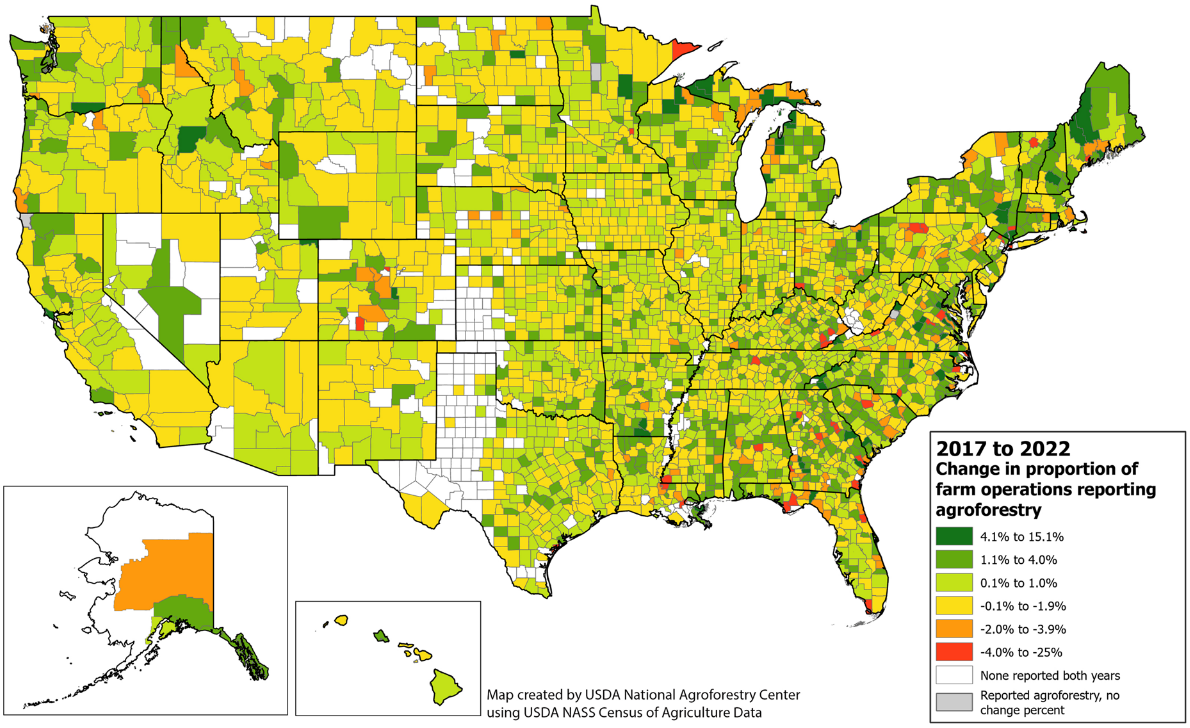

Fig. 8 Change in the proportion of farms reporting at least one agroforestry practice by county between the 2022 and 2017 United States Census of Agriculture reporting periods. Agroforestry practices included windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming (USDA NASS 2019a, 2024a)

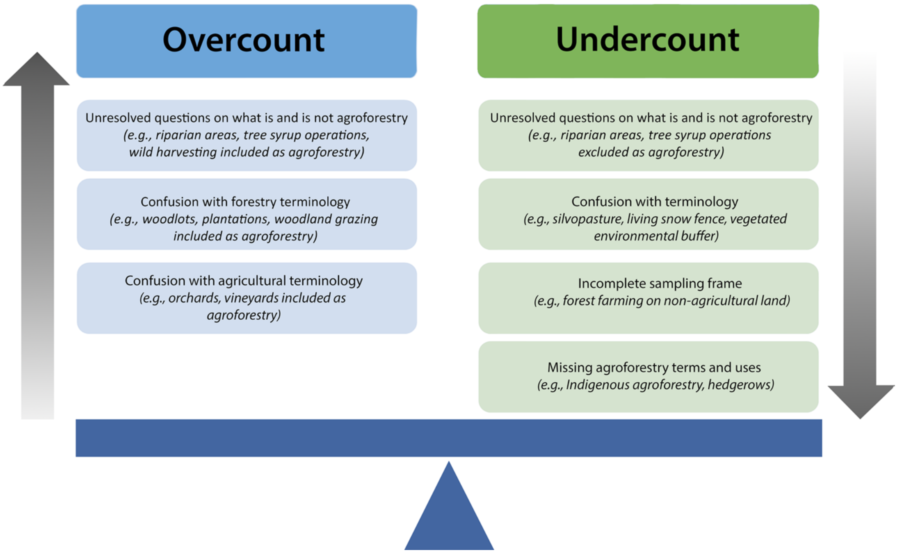

Fig. 9 Examples of factors contributing to an over- or undercount of agroforestry use in agroforestry surveys

2. Enhancing producer and natural resource professional understanding of agroforestry terminology.
3. Improving surveys by utilizing other sampling frames to target non-farmers who may have an agroforestry practice.

4. Conducting regional agroforestry surveys to help augment and refine national level data.

Investigating the drivers behind changes in adoption is needed so that policy, programs, markets, and other factors may be used in leveraging support for appropriate and sustainable adoption of agroforestry. Through follow up surveys using the census sampling frame, drivers of adoption (i.e. intent) can be assessed (FAO 2017; Smith et al. 2022a). These surveys could also assess the number of acres within each agroforestry practice, which is not currently reported in the COA.

Examination of geographical variables at the county scale may also provide increased understanding of possible mechanisms underlying trends in agroforestry extent. For example, when overlaying the 2022 COA data over climate zones from (Kottek et al. 2006), 44% of the counties reporting zero agroforestry in the United States lie within or have some area within a semi-arid or desert climate zone. More comprehensive geospatial analyses will likely find other geographic and biophysical variables influencing agroforestry adoption at the landscape level. Further, geospatial analyses using agroforestry extent data could be used to identify critical gaps where agroforestry implementation is lacking, but may have the greatest impact (Schoeneberger et al. 2017). For example, the Buffering America's Waterways Tool (Lilja et al. 2023) assesses watersheds where riparian buffers could have the greatest impact to protect and enhance surface drinking water. This decision support tool incorporates many different geospatial layers to identify critical agroforestry gaps. Other types of geospatial analysis using remote sensing techniques have been successful at identifying trees in agricultural areas (Liknes et al. 2017; Meneguzzo et al. 2013), yet these methods alone fall short in identifying agroforestry due to the difficulty of understanding producer intent.

Looking ahead to the next COA in 2027, it will be interesting to see how agroforestry extent changes given the increased support for agroforestry through the Inflation Reduction Act and the USDA Partnerships for Climate-Smart Commodities, which both started in 2022. For example, the Partnerships for Climate-Smart Commodities is supporting 39 projects that have agroforestry within their project scope, including a $60 million project dedicated solely to agroforestry (USDA 2024). Based on this enhanced support and the increased interest shown by producers between census years, the future looks bright for agroforestry in the United States.

Acknowledgements This work was supported in part by the U.S. Department of Agriculture, Forest Service. The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy. Further, this research was supported in part by an appointment to the United States Forest Service (USFS) Research Participation Program administered by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement between the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA). ORISE is managed by ORAU under DOE contract number DE-SC0014664. All opinions expressed in this paper are the author's and do not necessarily reflect the policies and views of USDA, DOE, or ORAU/ORISE.

Author contribution All authors contributed to the study conception and design. All authors collectively wrote and reviewed the manuscript. TK and SF also conducted data analysis and created all figures and graphics.

Data availability GIS data layers for this study will be freely available on the United States Department of Agriculture, Forest Service Research Data Archive (https://www.fs.usda.gov/rds/archive/) or from the lead author of this study.

Declarations

Conflict of interests The authors declare no competing interests.

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