Agroforest Syst (2026) 100:158
https://doi.org/10.1007/s10457-026-01516-5

Global agroforestry adoption: A meta-analysis of econometric-based studies

Kelsi Stubblefield · Zhen Cai · Matthew M. Smith · Sarah Lovell · Mary Hendrickson

Received: 12 January 2026 / Accepted: 13 April 2026 / Published online: 26 May 2026

Abstract Agroforestry systems are increasingly recognized as providing multiple economic, ecological, and social benefits. These benefits have led to increases in agroforestry adoption across many regions of the world. Understanding which benefits lead producers to adopt agroforestry, or which challenges discourage adoption, is of critical importance to advance agroforestry implementation. This meta-analysis reviewed agroforestry adoption studies published between January 2000 and June 2024 and identified 94 observations from 76 econometric studies, encompassing research from 30 countries. Trends in number of publications, geographic focus, econometric models employed, and factors that influenced engagement with agroforestry were explored. Results show that most econometric studies analyzed were conducted in Africa, and the logit model was the preferred econometric approach. Of the 23 variables used in the meta-analysis to explore factors that influence engagement in agroforestry, only nine were found to be significant over 50% of the time. Variables most likely to predict agroforestry engagement were available labor, farmer knowledge of agroforestry or tree planting, and farmer contact with extension services. Findings from this study highlight the inconsistency in agroforestry definitions used globally, the complexity of the adoption process, and the inconsistency of variables used to predict agroforestry adoption across studies. The lack of predictive variables highlights the challenge of synthesizing agroforestry adoption data globally, where regional context, such as culture, policy, and geography have unique weight in the adoption process. Findings highlight the need for more regionally based analyses of agroforestry adoption.

Keywords Adoption · Econometric models · Meta-analysis · Survey · Perennial agriculture

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10457-026-01516-5.

K. Stubblefield (✉) · S. Lovell
University of Missouri Center for Agroforestry, Columbia, MO, US
e-mail: k.stubblefield@missouri.edu

Z. Cai
Forest Products Laboratory, USDA Forest Service, Madison, WI, US

M. M. Smith (✉)
National Agroforestry Center, USDA Forest Service, Lincoln, NE, US
e-mail: matthew.smith4@usda.gov

M. Hendrickson
Division of Applied Social Sciences, University of Missouri, Columbia, MO, US

Introduction

Agroforestry provides well-documented benefits such as crop and product diversification, improved soil health, increased water quality, creation of wildlife habitat, and improved landscape resilience (Pantera et al. 2021). Globally, agroforestry systems cover an estimated 1.6 billion hectares, with approximately 78% located in tropical regions and 22% in temperate areas (Nair et al. 2021). In Europe, agroforestry occupies around 15.4 million hectares within the European Union, accounting for about 9% of the utilized agricultural area, with silvopasture being the predominant practice (Augère-Granier 2020). In the United States, the total land area in agroforestry has not been quantified, though data for the number of farm operations exists, with over 32,000 farm operations reporting at least one agroforestry practice (USDA NASS 2024).

Previous reviews of agroforestry adoption literature have provided valuable insights into socioeconomic dimensions of agroforestry research. Mercer and Miller (1998) reviewed socioeconomic studies published in Agroforestry Systems between 1982 and 1996 and identified knowledge gaps, analyzed publication trends, and highlighted priority areas for future research. Montambault and Alavalapati (2005) compiled and examined over 500 studies on socioeconomic issues in agroforestry published from 1992 to 2002. Within this investigation, they analyzed the geographic distribution of studies, types of economic analyses (e.g., econometrics, cost–benefit, environmental economics, farm budgeting, optimization), agroforestry practices investigated (e.g., forest farming, intercropping), and key socioeconomic issues (e.g., economic and household benefits, market dynamics).

Other reviews have focused on identifying factors that influence landowners' adoption of agroforestry practices and strategies for improving agroforestry adoption. Pattanayak et al. (2003) reviewed 32 empirical studies on agroforestry technology adoption conducted globally between 1990 and 2001. Their meta-analysis employed a vote-count method to identify variables relevant to adoption outcomes across studies. Meijer et al. (2015) reviewed agroforestry adoption studies in sub-Saharan Africa, identifying extrinsic and intrinsic variables affecting the use of agroforestry technologies. Similarly, Amare and Darr (2020) reviewed agroforestry adoption studies from Africa published between 2005 and 2017, identifying variables influencing adoption and providing key insights into the complex, multifaceted nature of agroforestry adoption behavior.

While previous reviews remain valuable, the most recent meta-analysis identifying influential factors in agroforestry adoption on a comprehensive global scale was published more than twenty years ago (i.e. Pattanayak et al. 2003). More recent reviews, such as Zabala et al. (2025), have synthesized literature to compile drivers of adoption for agroforestry and sustainable land use innovations, but with the intent of illustrating the breadth of variables that may potentially influence adoption without inferring the significance or direction of these variables. Additionally, the study conducted by Zabala et al. (2025) employed methodology that expanded the studies beyond those employing regression models. This allowed for diversity and for researchers to comprehend approaches that were not included in previous reviews, yet they acknowledge that the selection was not a representative sample of studies on agroforestry adoption drivers.

By reviewing agroforestry adoption literature using econometric models, our objectives are to (1) determine whether predictive variables exist globally that influence farmers' engagement with agroforestry, and (2) assess adoption rates across studies and over time.

By conducting a meta-analysis of global agroforestry adoption literature, results could be applied to achieve various goals. For instance, relevant findings may inform policy and programming initiatives enacted by organizations with larger regional or global lenses. Additionally, if predictive variables exist for agroforestry adoption, then inferences could be made in regions where agroforestry studies have yet to occur. This may lead to targeted outreach efforts directed towards populations that are predicted to be more receptive of agroforestry. Furthermore, if consistent barriers are identified, then tangible steps could be taken to mitigate these obstacles.

Our review contributes to the literature in the following aspects. First, this study extends the work of Pattanayak et al. (2003) to include more recent publications and expands the scope of previous reviews (e.g. Meijer et al. 2015; and Amare and Darr 2020) by incorporating studies from temperate regions. Second, this review adheres to the definition of agroforestry as provided by the Food and Agriculture Organization (FAO) of the United Nations: "agroforestry is a collective term for land management systems where woody perennials are deliberately integrated with agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence" (Food and Agriculture Organization 2024). Consequently, some studies included in previous reviews were excluded from our meta-analysis. For instance, we omitted a study that defined landowners who adopted agroforestry as households growing or maintaining fertilizer tree and shrub species continuously over a five-year period, excluding households with non-nitrogen fixing trees (Coulibaly et al. 2017). We also incorporate a more comprehensive list of search terms used to describe agroforestry systems to account for terminology used across multiple countries. Third, recognizing the complexity of agroforestry adoption (Amare and Darr 2020; Pattanayak et al. 2003), we emphasize the importance of examining common variables and their influence on agroforestry engagement across empirical studies.

Methods

Study selection

Studies for this review were selected primarily through Web of Science, and additional databases such as ScienceDirect, Google Scholar, and Wiley Interscience were used as a check. The search was limited to peer-reviewed publications, book chapters, and conference proceedings published in English between January 2000 and June 2024. To identify relevant agroforestry-related terms for the search, we reviewed definitions and practices of agroforestry as outlined in the literature (e.g., Food and Agriculture Organization 2024; Gold and Garrett 2009; Montambault and Alavalapati 2005; Sinclair 1999; Smith et al. 2021) and consulted with agroforestry experts at the University of Missouri, Missouri, USA and the USDA National Agroforestry Center, Nebraska, USA. The original search string used in Web of Science was: (AB = (survey*) OR AB = (interview*)) AND (AB = (agroforestry) OR AB = ("riparian forest buffer*") OR AB = (windbreak*) OR AB = (shelterbelt*) OR AB = ("living snow fence*") OR AB = (silvopasture*) OR AB = (silvopastoral) OR AB = (dehesa*) OR AB = ("agro-silvopastoral") OR AB = (montado*) OR AB = ("alley cropping") OR AB = (intercropping) OR AB = ("improved fallow*") OR AB = ("forest farming") OR AB = ("food forest*") OR AB = ("multistory cropping") OR AB = ("multi-story cropping")). This string was later expanded to include additional terms frequently used in agroforestry. The additional string, which was attached to the original, included (AB = (hedgerow*) OR AB = (parkland*) OR AB = (taungya) OR AB = ("live fence*") OR AB = ("home garden*"). A total of 1,990 studies were identified. From this pool, 435 study abstracts were selected as needing further screening for potential inclusion.

Following screening, 76 studies (3.8% of the initial pool) were included based on the following criteria: a) a focus on the adoption of agroforestry, including adoption behavior, adoption interests, and/or the extent of adoption; b) research that explored human behavior or intentions; and c) inclusion of at least one regression model in which the adoption of agroforestry practices were the dependent variable, accompanied by a discussion of the significance of the independent variables. It is important to note that studies were excluded that contained agroforestry practices in combination with non-agroforestry practices. This was common for studies investigating home garden systems, where several studies combined respondents with home gardens as an agroforestry practice (i.e. trees, shrubs with crops) and non-agroforestry systems containing only annual crops. The results of this screening process align with findings from previous reviews. For example, Mercer and Miller (1998) identified 113 papers in their socioeconomic review of agroforestry, reporting that only 3% utilized quantitative or regression analysis. Similarly, Montambault and Alavalapati (2005) reviewed over 500 publications on socioeconomic research in agroforestry, noting that approximately 13% employed econometric models.

Meta-analysis

A meta-analysis was employed to achieve the research objectives of this study. Meta-analysis, as defined by Glass (1976), is a statistical method that integrates research findings from a large collection of individual studies. This approach has been extensively utilized in environmental economics to synthesize studies and identify factors influencing individual decision-making (e.g., Baumgart-Getz et al. 2012; Cai and Aguilar 2013; Yeganeh et al. 2020). In this study, a vote-count meta-analysis was conducted to identify the significant and insignificant variables in each study, as well as the direction of their influence (i.e. positive, negative, or insignificant influence) on agroforestry adoption outcomes. However, a meta-regression analysis could not be successfully applied to the data. Similar to the challenges encountered by Pattanayak et al. (2003) and Smith et al. (2022a, b), the inconsistency in the types of certain independent variables (e.g., the use of discrete, continuous, or categorical variables for income), the lack of sufficient summary statistics for explanatory variables in some studies, and missing data on marginal probabilities (effect size) impeded the application of meta-regression.

Vote-count analyses are conducted by tallying the instances when an independent variable displays a significant negative, significant positive, or insignificant correlation with a dependent variable. The use of vote-counting procedures is warranted when studies do not provide enough data or relevant information to calculate effect size estimates (Bushman and Wang 1994), and vote counting can provide insights into general relationships of variables across investigations, offering a "useful starting point for a systematic assessment of multiple studies" (Pattanayak et al. 2003). Vote-counting methods have often been applied to assess adoption of various farming and conservation technologies, such as studies by Pattanayak et al. (2003), Knowler and Bradshaw (2007), Baumgart-Getz et al. (2012), and Prokopy et al. (2019). Scholars have noted a few inherent weaknesses of vote counting. Namely, lacking consideration of study sample size or an inability to provide a measure of effect size to quantify the strength of relationship between two variables, such as a regression coefficient; others have pointed out that meta-analyses in general may also be subject to publication bias, where researchers may opt not to submit studies for publication that display only insignificant findings or publishers may not accept them (Baumgart-Getz et al. 2012; Vevea et al. 2019; Arslan et al 2022).

This study was conceptualized to build upon the work initiated by Pattanayak et al (2003), so methods aligned with their approach were employed, such as focusing on studies that statistically evaluate determinants of agroforestry engagement with consistent enough methodologies to make comparison meaningful. Yet, we also encountered similar difficulties as the Pattanayak team, such as inconsistent data inhibiting generation of quality-differentiated weights.

Data recording and coding

From the collected studies, we systematically recorded and coded variables that captured study characteristics, agroforestry adoption characteristics, and econometric model characteristics. The coding process consisted of two rounds. In the first round, one coauthor conducted the initial coding of all collected studies. In the second round, a different coauthor crosschecked the coding, identified inconsistencies, and added additional relevant studies due to new studies published after the initial search window. After these studies were incorporated, the full dataset was recorded to ensure consistency between coders.

Study characteristics included author names, title, publication year, and the number of observations within each study—considering that some studies may report multiple observations (e.g., conducted in different regions or countries). Additionally, we recorded the study region or country and determined whether the study or its observations were conducted in a tropical or temperate zone.

Agroforestry adoption characteristics encompassed adoption behavior (adoption versus non-adoption), adoption interests (interest in adoption versus lack of interest), and the extent of adoption (expanding the scale or intensity of already adopted practices).

Econometric model characteristics included the sample size, types of models employed in the studies, and the significance of the independent variables within these models. The Sustainable Livelihoods Framework (Scoones 1998; United Nations Development Programme 2017) served as the theoretical foundation for identifying and categorizing variables that influence agroforestry adoption. This framework posits that the livelihood of any community or individual is linked to their natural, human, social, financial, and physical capitals (Aguilar et al. 2021; Donovan and Stoian 2012). Applied to this meta-analysis, the framework was used to assess how these capital assets influence farmers' adoption of agroforestry practices. Within this context, natural capital refers to available resource stocks, such as soil, water, and environmental amenities. Human capital includes individual resources such as skills, knowledge, labor, and other attributes. Social capital pertains to community resources, including social infrastructure, relationships, networks, and institutions, such as farmer groups. Financial capital encompasses economic assets like cash, credit, debt, or valuable holdings, while physical capital refers to human-made assets such as infrastructure or facilities (Aguilar et al. 2021; Scoones 1998).

All data from this study were recorded and coded in Microsoft Excel. Stata 18 (StataCorp. 2023) was utilized to test statistical differences between: a) the number of publications between 2000–2011 and 2012–2023 (excluding 2024 publications since data collection ended in June 2024), b) adoption rates between tropical and temperate studies, and c) adoption rates between the periods 2000–2011 and 2012–2024. The non-parametric equality-of-medians test was employed to assess these statistical differences. Additionally, ArcGIS Pro 3.2 (Esri Inc. 2023) was used to create maps illustrating the geographic distribution of the included studies by country.

Results and discussion

Study characteristics

The 76 collected studies yielded a total of 94 observations (Online Resource 1), as some studies reported multiple observations. For example, Bhusal et al. (2023) examined agroforestry adoption on both private farmland and public land. Gyau et al. (2014) and Keil et al. (2005) explored both adoption behavior and adoption interests. Rajasekharan and Veeraputhran (2002) included several research regions within a single study, and Ndayambaje et al. (2012) developed three models to analyze determinants of agroforestry adoption across high, medium, and low altitude regions.

Between January 2000 and June 2024, there was an average of three studies published per year that employed econometric methods for agroforestry adoption (Fig. 1). The year 2023 had the highest number of publications, with seven studies included. It is important to note that the studies for 2024 only include publications up to June 2024. Prior to 2019, the number of publications remained relatively stable, with 26 studies published between 2000 and 2009, and another 26 studies between 2010 and 2019. This pattern aligns with the findings of Pattanayak et al. (2003), who reviewed 30 econometric-based agroforestry adoption studies published between 1990 and

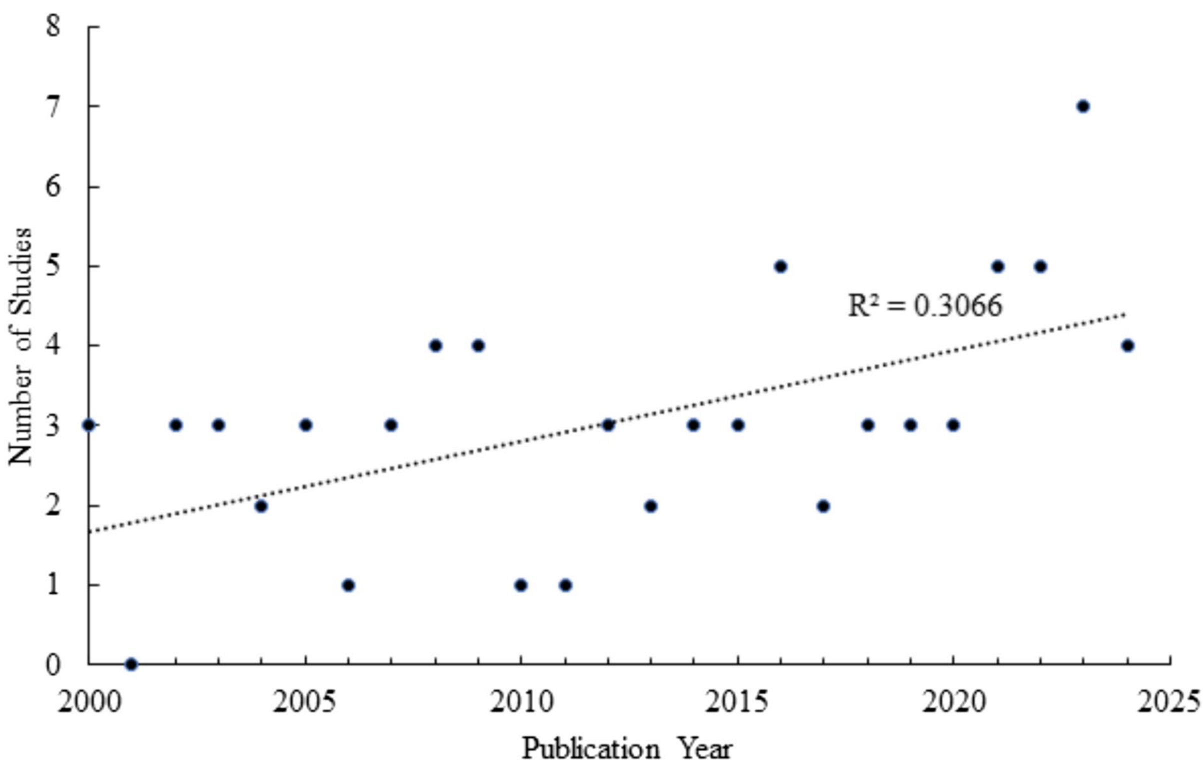

Fig. 1 Number of econometric-based agroforestry adoption studies included in this review by publication year

2001, excluding two studies that used t-tests. Notably, there has been a substantial increase in number of publications, with a total of 27 studies published between 2019 and June 2024. However, no statistical difference ($p = 0.346$) was found between 2012–2023 and 2000–2011 in terms of number of publications. Bibliometric analyses of the broad agroforestry literature have also found increases in the number of publications over the past few decades (Liu et al. 2019; Silao et al. 2023).

The 76 studies included in this review encompassed data from 30 countries. The most frequently studied countries were India (seven studies), Nepal (six studies), Uganda (six studies), and the United States (five studies) (Fig. 2). The geographical distribution of the studies revealed that 1.32% were from Europe, 27.63% from Asia, 11.84% from the Americas, and 59.21% from Africa. Of the total observations, 82 (87.23%) were conducted in tropical climates, while 12 (12.77%) were in temperate climates. This distribution is comparable to Pattanayak et al. (2003) meta-analysis, which found that 16% of studies reported findings from countries with a predominantly temperate climate.

Agroforestry adoption characteristics

Among the observations, 35.40% assessed "agroforestry" adoption broadly, without naming any specific agroforestry practices. Another term used in 10.62% of the observations representing agroforestry practices was "on-farm tree planting" or "tree planting on agricultural land," without further specification. While these general assessments of agroforestry practices provide valuable insights, there was substantial variability in how studies defined and applied agroforestry terminology. For instance, Sood and Mitchell (2009) classified farmers as agroforestry practitioners if at least one tree was present on their farmland. In contrast, other studies considered individuals as agroforestry practitioners only if they engaged in more intensive practices, such as intercropping or establishing woodlots (e.g., Kakhobwe et al. 2016).

Among the observations that specified agroforestry practices, "alley cropping" was the most frequently studied, accounting for 23.89% of all observations. Practices such as "improved fallows" and "silvopasture" each comprised 6.19% of the observations, while "riparian forest buffers" accounted for 5.22%. Practices like "windbreaks" (2.65%) and "forest farming" (1.77%) were less frequently examined. Other agroforestry practices, including "home gardens," "woodlots" (set aside portion of their farmland for woodlots), "taungya system," "cut-and-carry agroforestry," "border cropping," and "fodder banks," collectively represented 7.96% of the observations.

Regarding agroforestry adoption characteristics, 61 studies (80.26%) focused solely on adoption behavior, 11 studies (14.47%) examined adoption interests, one

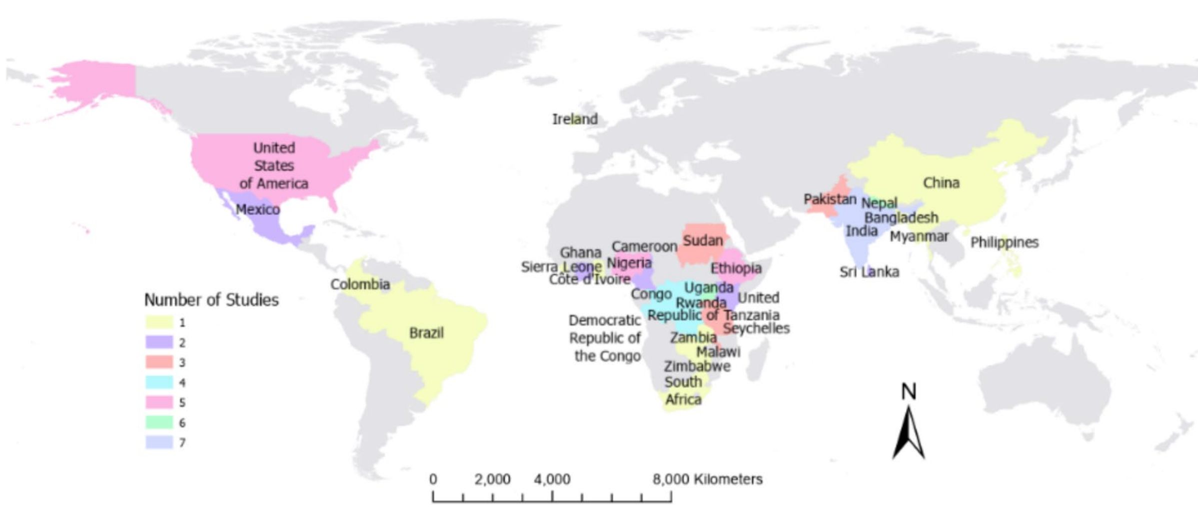

Fig. 2 Distribution of econometric-based agroforestry adoption studies included in review ($n = 76$)

study (1.32%) (Kachaka et al. 2020) investigated the extent of adoption, two studies (2.63%) (Casey 2004; Gyau et al. 2014) addressed both adoption behavior and adoption interests, and one study (1.31%) (Keil et al. 2005) examined both adoption behavior and the extent of adoption.

Adoption rates were analyzed for both actual adoption and adoption interests (Table 1). While many studies provided statistics on rates of agroforestry adoption within their study region or rates of interest, adoption rate values could not be found or derived from 24 of the observations. Also, adoption rates for specific agroforestry practices could not be calculated as some studies reported on multiple practices without providing individual adoption statistics. Additionally, one study was specifically designed to include an equal number of agroforestry adopters and non-adopters (50% each). Statistical analysis revealed no significant differences ($p = 0.161$) in adoption rates between tropical and temperate regions regarding adoption behavior. Due to a small sample size, statistical differences in rates of adoption interest between tropical and temperate regions could not be assessed.

In segmenting the studies by the periods 2000–2012 and 2013–2024, we examined potential shifts in agroforestry rates for adoption behavior over time. In studies from 2000–2012, agroforestry adoption rates varied from 26.00 to 75.50%, with an average adoption rate of 47.10%. In studies from 2013–2024, adoption rates ranged from 9.00 to 90.91%, with an average rate of 55.85%. However, statistical analysis revealed no significant difference in adoption rates between these two periods ($p = 0.625$).

Table 1 Agroforestry adoption rates calculated for both behavior and interests for studies published between January 2000 to June 2024

	Adoption rate[A] ($n = 78$)	Adoption interests[B] ($n = 14$)
Not stated	16 Observations	8 Observations
Average rate	51.11%	50.80%
Minimum rate	9.00%	28.48%
Maximum rate	90.91%	81.00%
Temperate region	64.79%	56.00%
Tropical region	50.84%	49.76%

[A]Adoption Rate = percentage of respondents in observations that reported actively practicing agroforestry

[B]Adoption Interest = percentage of respondents in observations that reported being interested in adopting agroforestry

These average adoption rates provide some insights into agroforestry's prevalence in these studies. Yet, these results should not be generalized or assumed to be reflective of agroforestry's true presence on the landscape, given the variability of factors such as agroforestry definitions across studies. For instance, the practice of "woodlots" is defined as and considered to be an agroforestry practice in a Rwanda-based study conducted by Ndayambaje et al. (2013). However, this practice would not meet the requirements to be considered agroforestry based on definitions and criteria used in many studies, which employ the Gold et al. (2000) definition of agroforestry practices as more intentional, intensive combinations of "trees and/or shrubs with crops and/or livestock." Additionally, many studies focused on small regions, where localized factors can significantly influence adoption. For instance, in a study area in Nepal, the introduction of an agroforestry education program by the Nepal Agroforestry Foundation led to higher adoption rates (63%) compared to neighboring regions (Neupane et al. 2002). Conversely, in Malawi, the provision of subsidies for non-agroforestry technologies potentially undermined agroforestry adoption rates (Toth et al. 2017). Such contextual factors can substantially affect adoption rates across different study regions. Therefore, while these adoption rates provide useful insights, they should be regarded with caution and not be seen as precise indicators of broader agroforestry adoption trends.

Econometric model characteristics

Survey sample sizes across the studies ranged from 30 to 2,007 participants, with an average sample size of 309 participants per study. The logit model emerged as the most frequently used econometric model in the collected observations followed by the probit model. Similarly, Pattanayak et al. (2003) identified the logit model as the most commonly used model in their meta-analysis, accounting for approximately half of the studies reviewed (Fig. 3).

Influential variables

Over 300 unique potential influential variables were identified in selected studies, coded, and sorted into

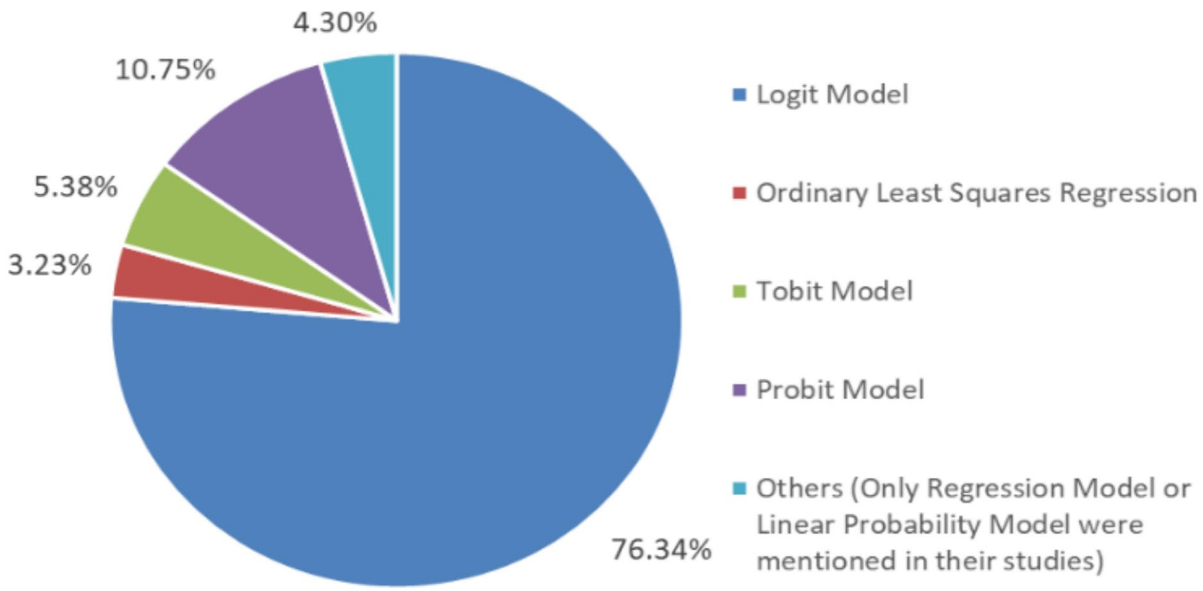

Fig. 3 Types of econometric models used in collected observations ($n=94$)

capital asset categories. As in other reviews and meta-analyses, variables were reviewed, coded, categorized, and aggregated as appropriate, and only 23 were selected for inclusion in the final analysis because they were represented within at least ten observations (Prokopy et al. 2019; Amare and Darr 2020; Arslan et al. 2022). Variables present in less than ten observations were included if they displayed significance in at least twenty five percent of observations from distinct studies. This was employed to potentially capture any emergent variables that may not yet be prevalent across agroforestry adoption literature, but have shown early potential to influence agroforestry engagement within the studies that have included them. Among the five capitals in the Sustainable Livelihoods Framework, human capital was the most frequently included in the collected studies, comprising nine variables. In contrast, social and physical capital were the least represented, with only three variables included. Natural and financial capitals each comprised four variables. Table 2 details the descriptions, counts, and significance levels for variables associated with each capital: natural, social, financial, physical, and human. The counts reflect the number of times each variable was included in the econometric models across all collected observations. For each variable, the table presents the percentages of positive significant variables, negative significant variables, and insignificant variables. Variables were also segmented out by continent to explore any potential regional trends. While not included in the results section, this table is available in Online Resource 2.

Natural capital

The FARMSIZE variable was generally positively correlated with agroforestry engagement (45.61%), indicating that individuals with larger farms were more likely to adopt agroforestry practices, engage in more intensive agroforestry, or express interest in agroforestry. This positive relationship may be attributed to the fact that farmers with larger landholdings have more space to experiment with agroforestry technologies, potentially facing lower risks compared to those with smaller plots (Mugure et al. 2013). However, FARMSIZE was found to be insignificant in 23 observations (40.35%), and significant and negatively correlated with agroforestry engagement in only eight observations. In the studies with negative correlations, smallholders were more likely to adopt agroforestry to meet subsistence needs, as agroforestry practices provided an opportunity to plant food crops among trees (Rajasekharan and Veeraputhran 2002). Pattanayak et al. (2003) also noted inconsistent correlations between farm size and agroforestry adoption, suggesting that land size might serve as a proxy

Table 2 Descriptions, counts, and significance of variables included in the meta-analysis of global agroforestry adoption literature

Variable	Description	Count	# positive	# negative	# insignificant	Positive significant %	Negative significant %	Insignificant %
Natural capital								
FARMSIZE	Farmer land and/or plot size	57	26	8	23	45.61%	14.04%	40.35%
TENURE	Farmer tenure and/or land rights status	21	6	3	12	28.57%	14.29%	57.14%
FSOIL	Healthy and/or fertile soil on farmer land (healthy/fertile soil = positive, otherwise = negative)	18	5	6	7	27.78%	33.33%	38.89%
SLOPE	Slope of farmer land	5	4	0	1	80.00%	0.00%	20.00%
Human capital								
AGE	Farmer age	72	13	22	37	18.06%	30.56%	51.39%
EDUCATION	General education level of farmer	66	29	0	37	43.94%	0.00%	56.06%
HHSIZE	Family and/or household size	54	12	3	39	22.22%	5.56%	72.22%
GENDER	Reported gender of farmer (man = positive, woman/other gender identity = negative)	48	19	5	24	39.58%	10.42%	50.00%
LABOR	Amount of labor available to farmer	22	11	1	10	50.00%	4.55%	45.45%
GFEXP	Farmer general farming experience	19	7	2	10	36.84%	10.53%	52.63%
AFKNOW	Farmer knowledge of AF practices	13	8	1	4	61.54%	7.69%	30.77%
AFEXP	Farmer AF or tree planting experience	8	6	0	2	75.00%	0.00%	25.00%
NATIVE	Farmer place of origin (local = positive, otherwise = negative)	7	2	0	5	28.57%	0.00%	71.43%
Social capital								
EXT	Farmer contact with extension services	36	24	0	12	66.67%	0.00%	33.33%
MEMBER	Farmer membership to farming organizations or groups	34	15	1	18	44.12%	2.94%	52.94%
TRAIN	Farmer participation in skill and/or AF technical training	2	1	0	1	50.00%	0.00%	50.00%
Financial capital								
INCOME	Farmer income and/or wealth status	30	9	2	19	30.00%	6.67%	63.33%
LIVESTOCK	Number of livestock owned by farmer	23	8	3	12	34.78%	13.04%	52.17%
CREDIT	Farmer access to credit and/or savings	15	4	0	11	26.67%	0.00%	73.33%

Table 2 (continued)

Variable	Description	Count	# positive	# negative	# insignificant	Positive significant %	Negative significant %	Insignificant %
OFF-FARM	Farmer and/or household participation in off-farm employment/activities/income	14	6	1	7	42.86%	7.14%	50.00%
Physical capital								
DISMARKET	Distance of farm to nearest market	9	3	2	4	33.33%	22.22%	44.44%
DISFUEL	Distance of farm to nearest source of fuelwood/firewood	6	3	2	1	50.00%	33.33%	16.67%
DISRES	Distance of farm to field of residence	5	0	2	3	0.00%	40.00%	60.00%

AF = Agroforestry

for other factors such as risk tolerance, economic necessity, or wealth.

The TENURE variable was insignificant at influencing agroforestry engagement in 12 of the 21 observations (57.14%), indicating that land rights may not consistently affect agroforestry outcomes. When the TENURE variable was significant, it was predominantly positively correlated with agroforestry engagement (28.57%), suggesting that secure land rights may encourage agroforestry adoption outcomes in some instances. These findings align with Pattanayak et al. (2003) review of agroforestry adoption studies, which also noted inconsistent relationships between tenure and agroforestry adoption. This finding is also consistent with Ranjan et al. (2022) for conservation behavior more broadly. The inconsistent impact of TENURE on agroforestry engagement may suggest this variable is closely tied to the contexts of specific countries and regions, supporting a call for more regionally tailored analyses that consider these nuances.

The FSOIL variable was examined in 18 observations, with seven reporting insignificance (38.89%) and 11 identifying it as a significant factor influencing agroforestry engagement, though this significance was almost evenly divided between positive correlation (27.78%) and negative correlation (33.33%). When significant, FSOIL was generally negatively correlated with agroforestry engagement, potentially suggesting that individuals with poor or degraded soils might be more inclined to adopt agroforestry practices. For instance, one study indicated that farmers with "steep and heavily degraded soils" were more knowledgeable about agroforestry practices and their potential for soil and water conservation (Zerihun et al. 2014).

SLOPE was included in five observations and found to be significant in four. Most of these significant observations indicated a positive correlation between SLOPE and agroforestry engagement, suggesting that individuals with steeply sloped land are more likely to adopt agroforestry practices, which can reduce erosion and enhance landscape resilience. However, SLOPE was infrequently included in the studies, indicating that further research may be necessary to better understand its relationship with agroforestry engagement.

Human capital

AGE was included in 72 observations and was an insignificant factor in 51.39%. When significant, AGE was predominantly negatively correlated with agroforestry engagement (30.56%), indicating that older farmers were less likely to practice agroforestry, engage more intensively, or express interest in it. Conversely, younger farmers were more inclined to adopt agroforestry. This finding is consistent with studies like Mattia et al. (2018), which identified younger farmers as having higher potential for adoption. The negative impact of age on agroforestry adoption may be attributed to the long-term nature of agroforestry investments, where older farmers may be less willing to undertake due to a reluctance to engage in new activities and make initial capital investments (Jara-Rojas et al. 2020). Despite this trend, it is worth restating that AGE was found to be insignificant in about half of the observations. Thirteen studies reported a significant positive correlation with AGE, often citing the experience and skills of older farmers as a reason for adoption. These findings suggest an inconsistent effect of AGE across different populations, and may also indicate the value of smaller, more regionally focused investigations that account for contexts influencing the variable.

The HHSIZE variable was included in 54 observations, but it was mostly found to be insignificant (72.22%). In the observations where HHSIZE was significant, it was nearly always positively correlated with agroforestry engagement (22.22%), suggesting that larger households were more likely to adopt agroforestry. This outcome is often attributed to the increased availability of family members to assist with labor-intensive agroforestry practices.

GENDER was measured in 48 observations and was insignificant in 50% of these. When significant, the frequent positive correlation of GENDER (39.58%) indicates that men were more likely to engage in agroforestry practices compared to women. Studies with this correlation often explained that existing regional power structures favored men, limiting women's access to land rights, resources, and decision-making opportunities, thereby inhibiting their adoption of agroforestry (Basamba et al. 2016; Pompeu et al. 2012; Buyinza and Naagula 2009). Conversely, five observations reported GENDER as significant and negatively correlated, indicating that women were more likely to engage in agroforestry than men. For example, in one study, men were found to be more likely to migrate for employment, leaving women to manage the household and land, which resulted in higher adoption of agroforestry practices by women (Neupane et al. 2002).

LABOR was examined in 22 observations and was found to be a significant, positively correlated variable in 50% of these. This suggests that greater access to labor may increase the likelihood of adopting agroforestry or adopting it more extensively. However, it is important to note that LABOR was found to be insignificant in nearly as many observations (45.45%), again limiting generalizable inferences and signifying the importance and influence of local and regional circumstances over such variables.

The GFEXP variable was included in 19 total observations and was insignificant in ten and significant in nine. Of the significant cases, seven reported a positive correlation between GFEXP and agroforestry engagement (36.84%), while two reported a negative correlation. This inconsistency may be due to experienced monoculture farmers having strong conventional farming identities, which may conflict with agroforestry practices (Arbuckle et al. 2009).

The NATIVE variable was included in seven observations and was insignificant in most of them (71.43%), perhaps suggesting that it is not a consistent predictor of agroforestry engagement or may warrant further investigation. When significant, NATIVE was negatively correlated (28.57%), suggesting that immigrants were more likely in these instances to engage in agroforestry than native residents.

AFKNOW was included in 13 observations. Eight studies reported a significant positive correlation with agroforestry engagement (61.54%), while four studies found the variable to be insignificant (30.77%) and one found a significant negative correlation (7.69%). The study documenting a negative correlation suggested that farmers with more knowledge of agroforestry might be deterred by constraints such as tree-crop competition, land tenure issues, insufficient plot size, and additional labor requirements, leading them to perceive agroforestry as a less viable option (Etshekape et al. 2018). Researchers in this study acknowledged that the negative influence in this study was unexplained and recommended further investigation into the relationship between agroforestry knowledge and adoption.

Regarding other Human Capital variables, EDUCATION was included in 66 observations and was mostly insignificant (56.06%). Although EDUCATION was significant in only 43.94% of the studies, it was always positively correlated with agroforestry adoption when significant. Additionally, AFEXP showed high rates of significance, and it was always positively correlated with agroforestry engagement in the eight studies that included it (75%). This suggests that greater experience with agroforestry practices enhances the likelihood of engagement.

Social capital

Of the 94 observations, MEMBER was included in 34, EXT in 36, and TRAIN in only two. All these variables were found to be significant in over 40% of the observations in which they were included. When significant, these variables were predominantly positively correlated with agroforestry engagement (66.67% for EXT, 44.12% for MEMBER, 50% for TRAIN). This indicates that individuals who are members of farming organizations or groups, have greater contact with extension services, and have participated in agroforestry training or skill development may be more likely to engage with agroforestry practices. However, it is also worth noting that MEMBER and TRAIN were insignificant in half of the observations that included them.

Financial capital

INCOME was measured in 30 observations and was most often insignificant at affecting agroforestry engagement outcomes (63.33%). Franzel et al. (2003) theorized that INCOME was insignificant because some agroforestry practices, such as improved fallow, require low capital and labor requirements, making it easier for resource-poor farmers to engage with the practices. When INCOME was significant, the correlation was mainly positive (30%), suggesting that some wealthier farmers may be more likely to adopt agroforestry, express interest in agroforestry, or adopt agroforestry to a greater extent. Many studies postulated that wealthier farmers possessed more disposable income for establishing agroforestry technologies, whereas resource limited farmers may be unable to bear the risks involved with agroforestry systems, such as high initial investment costs related to certain practices or the extended period before return on investment from tree crops or timber (Moronge and Nyamweya 2019; Ruheza et al 2012; Sood and Mitchell 2009).

The LIVESTOCK variable was included in 23 observations, with 52.17% finding the variable to be an insignificant influencer of agroforestry engagement. When significant, LIVESTOCK was mostly positively correlated (34.78%), signifying that the greater the number of livestock owned or managed by the farmer, the more likely they were to engage with agroforestry practices. Many studies intimated that the number of heads of livestock owned by a farmer was often a proxy variable for wealth and resource availability, and many farmers may use livestock as a means of storing and trading revenue. This indicates that farmers with greater wealth and resources may own more livestock and therefore may be more likely to engage with agroforestry practices than those with fewer resources and financial means (Jara-Rojas et al. 2020; Caviglia-Harris 2003).

CREDIT was included in 15 observations and was found largely insignificant at influencing agroforestry engagement (73.33%). In instances where CREDIT was significant, it was always positively correlated with agroforestry engagement (26.67%), indicating that farmers with access to credit and/or savings in these studies were more likely to practice agroforestry, practice it more intensively, or express interest in practicing it.

Only 14 observations included the OFF-FARM variable, and half of these found the variable to be insignificant. Six observations documented a significant and positive correlation (42.86%), while the remaining observation reported a significant and negative correlation. These findings suggest that household or farmer participation in off-farm activities or jobs positively influenced agroforestry engagement in some regions, but in others it was insignificant or inconsistent.

Physical capital

DISMARKET was included in nine observations and was most often insignificantly correlated with agroforestry outcomes (44.44%). When significant, it was often positively correlated with agroforestry engagement (33.33%), suggesting that as the distance of a farmer's residence increased from the nearest available marketplace, agroforestry engagement likelihood increased. There were 2 observations that displayed a negative influence, which may be attributed to the increased energy, time, and financial means required for traveling to the market. DISFUEL was included in six observations. In most of the observations, DISFUEL displayed a positive influence on agroforestry adoption when significant (50%). This suggests that farmers residing further away from sources of fuelwood may be more likely to engage with agroforestry in some areas. DISRES was included in only five observations and displayed an insignificant impact on agroforestry adoption in more than half of these observations (60%). For each of these variables, it is worth noting that only a small number of observations included them, so inferences about their significance and effect should be approached with caution.

Overall trends

It is important to acknowledge the inconsistencies observed across many variables, which can be partially attributed to the inherent complexity of agroforestry adoption. Variables such as gender may exhibit diverse impacts—positive, negative, or insignificant—due to regional contexts, including customs, religious practices, and available resources. Empirical studies on agroforestry adoption often underexplore these contextual factors. For instance, one study revealed that although a high percentage of women expressed a desire to adopt agroforestry, their ability to make technology adoption decisions was frequently constrained by their husbands, reflecting broader cultural and societal norms (Akoto et al. 2018). Studies like Akoto et al. (2018) that engage with female participants often allow for richer examinations of cultural context and highlight the importance of understanding gender dynamics in agroforestry adoption. However, many studies fail to address such nuances, a finding also reported by Silao et al. (2023) in their review of agroforestry research trends over the past four decades. Similarly, other variables are significantly influenced by regional, cultural, and societal norms. These key contextual factors can be lost when compiling global data for analysis.

Findings from studies employing econometric models aim to offer broader applicability compared to qualitative research (Amare and Darr 2020). However, in addition to an understanding of key regional dynamics, researchers should also consider the extensive experimentation and adjustments that occur before agroforestry innovations diffuse through a community or region. Understanding this process is crucial for developing complex and dynamic models of agroforestry adoption (Mercer 2004; Amare and Darr 2020). The agroforestry field would benefit from studies that examine how agroforestry practices evolve over time on landscapes and consider adoption as a continuous process rather than a simple binary choice.

Studies often include diverse variables on agroforestry adoption. External and characteristic variables such as slope, age, gender, and household size cannot be altered, while factors such as a land manager's perceptions, agroforestry experience, knowledge, or participation in skills training may be affected by targeted policies and programs. Yet the way these variables and others interlink and influence one another is often unclear or inconsistent across study regions (Zabala et al. 2025). Tailored analyses that consider the unique nature of these variables and how they interact may assist researchers with understanding the complex, interconnected nature of agroforestry adoption, allowing for more actionable recommendations across study regions.

Limitations

The authors acknowledge this study was subject to certain limitations. In order to retain a sufficient number of entries in the meta-analysis, studies on a variety of agroforestry practices were included. Individual agroforestry practices differ broadly in their implementation strategies, management demands, costs, and more. Thus, these practices may have different or unique influential variables associated with their adoption. Additionally, econometric studies on all aspects of agroforestry adoption were included, including both adoption rate, adoption extent, and adoption interest. Inherently, actual adoption behavior is different than an expressed interest in adoption.

Importantly, a core objective of this investigation was to identify any consistent predictors of agroforestry engagement across various contexts and populations, yet combining studies from a variety of regions and contexts reduces communication and consideration of nuance. For instance, the studies in this analysis were predominantly from Africa (59.21%), which likely influenced the final list of variables and the overall trends of significance. The dominance of African studies led to the inclusion of certain variables such as DISMARKET, which may not be a relevant influential factor over agroforestry engagement in other regions.

By grouping studies together at a global scale, the unique policies, cultures, structures, and resources within individual regions are underrepresented in the final analysis. Incorporating these perspectives into research can enhance understanding and clarify how specific factors impact agroforestry adoption outcomes. Engaging with these contextual elements will provide a more comprehensive view of the predictors of agroforestry adoption and improve the relevance and applicability of research findings.

Conclusions

This meta-analysis examined 76 empirical agroforestry adoption studies, encompassing 94 observations, that employed econometric analysis. The studies, published between January 2000 and June 2024, reveal no statistical difference in the number of publications from 2000–2011 to 2011–2023. Reported agroforestry adoption rates have remained stable in recent years, though any generalizations should be approached with caution given the variable definitions and approaches employed across studies. The literature predominantly focused on tropical regions, with over half of the studies conducted in Africa, yet no statistically significant differences ($p = 0.161$) in rates of adoption between tropical and temperate regions were observed. Additionally, limited data, prevalent cultural and regional nuances, and a disproportionate concentration of tropical versus temperate observations complicated efforts to compare influential variables between these regions. Though formal comparison of influential variables across geographies was not included in this investigation, tables of influential variables by continent have been provided in Online Resource 2. The final analysis identified 23 frequently studied variables related to agroforestry adoption, representing the five forms of capital outlined in the Sustainable Livelihoods Framework. Notably, the impacts of these variables on agroforestry adoption were inconsistent, with 14/23 variables having insignificant rates of no less than 50% and positive and negative correlations often canceling each other out.

Findings from this investigation provide some insights and recommendations for future research. Namely, inconsistencies in agroforestry terminology may inhibit future investigations into agroforestry adoption and diffusion. While some scholars use the term “agroforestry” to signify the presence of one or a few scattered trees across an agricultural operation, others define agroforestry as more intensive and integrated practices. Furthermore, some studies investigate the adoption of trees intensively integrated onto agricultural land, yet the term ‘agroforestry’ is never employed. Additionally, varying definitions and understandings of agroforestry nomenclature and practices in the academic landscape may inhibit research endeavors. Scholars searching for research studies using ‘agroforestry’ terminology may discover many works that use the same term, but feature practices inconsistent with their perceptions. Consistent definitions of agroforestry and related practices would promote unified understanding of agroforestry technologies and enhance precision of agroforestry research, especially for meta-analyses that combine data from multiple studies. However, there are fundamental challenges in conducting global-scale assessments that consistent terminology will not likely resolve.

The analysis of these studies underscores the complexities inherent in the agroforestry adoption cycle and reveals how the physical and academic landscape surrounding agroforestry has evolved over time. The variables identified in this study offer valuable insights for inclusion in regression models, enhancing our understanding of the factors influencing agroforestry adoption. These findings contribute to a more comprehensive understanding of the current research landscape while also supporting the design of meaningful studies aimed at assessing and promoting agroforestry adoption across diverse populations and geographies. Furthermore, intentional investigations into the larger social, cultural, regional, and systemic contexts that inform the influence of key variables may provide an enriched perspective and clarify the relationship of these factors to agroforestry adoption in given study regions.

Acknowledgements This study was supported by the National Institute of Food and Agriculture, award number 2014-68006-22041, the Missouri Department of Agriculture, award number 00062415, United States Department of Agriculture – Agricultural Research Service under agreement number 59-6020-5-001, the University of Missouri Center for Agroforestry and the United States Department of Agriculture – Agricultural Research Service Dale Bumpers Small Farm Research Center. This work was supported in part by the United States 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 United States Department of Agriculture or United States

Government determination or policy. The authors would like to acknowledge Gary Bentrup at the USDA National Agroforestry Center for his review of this manuscript.

Author contributions Kelsi Stubblefield designed the study, performed data collection and analysis, generated Tables 1 and 2, and wrote the main manuscript text. Zhen Cai advised and assisted in study design and data analysis. Additionally, Zhen Cai prepared Figs. 1, 3. Matthew Smith advised on study design and prepared Fig. 2. Sarah Lovell advised on study design and data analysis. Mary Hendrickson advised on data analysis. All authors reviewed and edited the manuscript.

Funding Agricultural Research Service, 59-6020-5-001, Missouri Department of Agriculture, 00062415, U.S. Forest Service, National Institute of Food and Agriculture, 2014-68006-22041.

Data availability Data used in this study were compiled from a search of qualifying literature. A list of included studies is provided in Online Resource 1.

Declarations

Conflict of interest This work stemmed from a chapter within a master's thesis. The provided author order is reflective of our respective contributions. The authors have no conflicts of interest to declare relevant to the content of this article. We also have no known financial or non-financial competing interests related to this manuscript.

References

Aguilar FX, Hendrawan D, Cai Z, Roshetko JM, Stallmann J (2021) Smallholder farmer resilience to water scarcity. Environ Dev Sustain. https://doi.org/10.1007/s10668-021-01545-3

Akoto D, Denich M, Partey S, Frith O, Kwaku M, Mensah A, Borgemeister C (2018) Socioeconomic indicators of bamboo use for agroforestry development in the Dry Semi-Deciduous Forest Zone of Ghana. Sustainability 10(7):2324. https://doi.org/10.3390/su10072324

Amare D, Darr D (2020) Agroforestry adoption as a systems concept: a review. For Policy Econ. https://doi.org/10.1016/j.forpol.2020.102299

Arbuckle JG, Valdivia C, Raedeke A, Green J, Rikoon JS (2009) Non-operator landowner interest in agroforestry practices in two Missouri watersheds. Agrofor Syst 75:73–82. https://doi.org/10.1007/s10457-008-9131-8

Arslan A, Floress K, Lamanna C, Lipper L, Rosenstock TS (2022) A meta-analysis of the adoption of agricultural technology in Sub-Saharan Africa. PLoS Sustain Transform 1(7):e0000018. https://doi.org/10.1371/journal.pstr.0000018

Augère-Granier ML (2020) Agroforestry in the European Union. Retrieved 05 Jan 2026 from https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/651982/EPRS_BRI(2020)651982_EN.pdf.

Basamba TA, Mayanja C, Kiiza B, Nakileza BR, Matsiko FB, Nyende P, Kukunda EB, Tumushabe A, Ssekabira K (2016) Enhancing adoption of agroforestry in the Eastern agro-ecological zone of Uganda. Int J Ecol Sci Environ Eng 3(1):20–31

Baumgart-Getz A, Prokopy LS, Floress K (2012) Why farmers adopt best management practice in the United States: a meta-analysis of the adoption literature. J Environ Manage 96(1):17–25. https://doi.org/10.1016/j.jenvman.2011.10.006

Bhusal P, Awasthi KR, Low M, Shrestha N, Neupane A, Paudel NS, Chhetri BBK, Parajuli R (2023) What determines the adoption of agroforestry practices in farmlands and public lands? a case study from the Terai Region in Nepal. Soc Nat Resour 37(2):234–250. https://doi.org/10.1080/08941920.2023.2269531

Bushman BJ, Wang MC (1994) Vote-counting procedures in meta-analysis. Handbook Res Synth 236:193–213

Buyinza M, Naagula A (2009) Predictors of agroforestry technology adoption and land conservation strategies in the highlands of South Western Uganda. J Earth Sci 3(2):46–55

Cai Z, Aguilar FX (2013) Meta-analysis of consumer's willingness-to-pay estimates for certified wood products. J Forest Econ 19:15–31. https://doi.org/10.1016/j.jfe.2012.06.007

Casey JF (2004) Agroforestry adoption in Mexico: using Keynes to better understand farmer decision-making. J Post Keynesian Econ 26(3):505–521

Caviglia-Harris JL (2003) Sustainable agricultural practices in Rondonia, Brazil: do local farmer organizations affect adoption rates? Econ Dev Cult Change 52(1):23–49. https://doi.org/10.1086/380137

Coulibaly JY, Chiputwa B, Nakelse T, Kundhlande G (2017) Adoption of agroforestry and the impact on household food security among farmers in Malawi. Agric Syst 155:52–69. https://doi.org/10.1016/j.agsy.2017.03.017

Donovan J, Stoian D (2012) Five Capitals: A tool for assessing the poverty impacts of value chain development. Turrialba: CATIE. Retrieved 05 Jan 2026 from https://www.cifor-icraf.org/knowledge/publication/10487/.

Esri Inc. *ArcGIS Pro* 3.2. Software. Redlands, CA: Esri Inc 2023.

Etshekape PG, Atangana AR, Khasa DP (2018) Tree planting in urban and peri-urban of Kinshasa: survey of factors facilitating agroforestry adoption. Urban for Urban Green 30:12–23. https://doi.org/10.1016/j.ufug.2017.12.015

Food and Agriculture Organization (2024). About Agroforestry. Retrieved 05 Jan 2026 from https://www.fao.org/agroforestry/about-agroforestry/overview/en.

Franzel S, Phiri D, Mafongoya P (2003). The blending of participatory research and quantitative methods: wealth status, gender and the adoption of improved fallows in Zambia. Proceedings of the 25th International Conference of Agricultural Economists (IAAE) 16–22 August 2003 Durban, South Africa, August, 700–708. Retrieved 05 Jan 2026, from http://ecsocman.hse.ru/data/873/659/1219/051.pdf.

Glass GV (1976) Primary, secondary, and meta-analysis of research. Educ Res 5:3–8

Gold MA, Rietveld JW, Garrett HE (2000) Agroforestry nomenclature, concepts and practices for the United States. In: Garrett HE, Rietveld JW, Fisher RF (eds) North American agroforestry: an integrated science and practice. American Society of Agronomy, Madison, pp 63–78

Gold MA and Garrett HE 2009 Agroforestry nomenclature, concepts, and practices. North American agroforestry: an integrated science and practice, pp.45–56. https://doi.org/10.1002/9780891183785.ch2.

Gyau A, Smoot K, Kouame C, Diby L, Kahia J, Ofori D (2014) Farmer attitudes and intentions towards trees in cocoa (*Theobroma cacao* L.) farms in Côte d'Ivoire. Agrofor Syst 88:1035–1045. https://doi.org/10.1007/s10457-014-9677-6

Jara-Rojas R, Russy S, Roco L, Fleming-Muñoz DA, Engler A (2020) Factors affecting the adoption of agroforestry practices: insights from silvopastoral systems of Colombia. Forests 11:648. https://doi.org/10.3390/f11060648

Kachaka ÉY, Munson AD, Gélinas N, Khasa D (2020) Adoption of an improved fallow practice using *Acacia auriculiformis* on the Batéké Plateau in the Democratic Republic of the Congo. Agrofor Syst 94:1047–1058. https://doi.org/10.1007/s10457-019-00474-5

Kakhobwe CM, Kamoto JF, Njoloma JP, Ozor N (2016) Scaling up agroforestry farming systems: lessons from the Malawi agroforestry extension project. J Agric Ext 20(1):153–162. https://doi.org/10.4314/jae.v20i1.13

Keil A, Zeller M, Franzel S (2005) Improved tree fallows in smallholder maize production in Zambia: do initial testers adopt the technology? Agrofor Syst 64:225–236. https://doi.org/10.1007/s10457-004-2410-0

Knowler D, Bradshaw B (2007) Farmers' adoption of conservation agriculture: a review and synthesis of recent research. Food Policy 32(1):25–48

Liu W, Yao S, Wang J, Liu M (2019) Trends and features of agroforestry research based on bibliometric analysis. Sustainability 11(12):3473. https://doi.org/10.3390/su11123473

Mattia CM, Lovell ST, Davis A (2018) Identifying barriers and motivators for adoption of multifunctional perennial cropping systems by landowners in the Upper Sangamon River Watershed, Illinois. Agrofor Syst 92(5):1155–1169. https://doi.org/10.1007/s10457-016-0053-6

Meijer SS, Catacutan D, Ajayi OC, Sileshi GW, Nieuwenhuis M (2015) The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. Int J Agric Sustain 13(1):40–54. https://doi.org/10.1080/14735903.2014.912493

Mercer DE (2004) Adoption of agroforestry innovations in the tropics: a review. Agrofor Syst 61(1):311–328. https://doi.org/10.1023/B:AGFO.0000029007.85754.70

Mercer DE, Miller RP. Socioeconomic research in agroforestry: progress, prospects, priorities. In: directions in tropical agroforestry research: Adapted from selected papers presented to a symposium on tropical agroforestry organized in connection with the annual meetings of the American Society of Agronomy, Springer Netherlands, 5 Nov 1996, Indianapolis, Indiana, USA 1998 (pp. 177-193).

Montambault JR, Alavalapati JRR (2005) Socioeconomic research in agroforestry: a decade in review. Agrofor Syst 65(2):151–161. https://doi.org/10.1007/s10457-005-0124-6

Moronge J, Nyamweya JM (2019) Some socio-economic drivers of agroforestry adoption in Temiyotta Location, Nakuru County, Kenya. J Sustain Environ Peace 2(1):9–14

Mugure A, Oino PG, Sorre BM (2013) Land ownership and its impact on adoption of agroforestry practices among rural households in Kenya: a case of Busia County. Int J Innov Appl Stud 4:552–559

Nair PR, Kumar BM, Nair VD, Nair PR, Kumar BM, Nair VD (2021) Global distribution of agroforestry systems. An introduction to agroforestry: four decades of scientific developments. 45–58. https://doi.org/10.1007/978-3-030-75358-0_4.

Ndayambaje JD, Heijman WJ, Mohren GMJ (2012) Household determinants of tree planting on farms in rural Rwanda. Small-Scale for 11:477–508. https://doi.org/10.1007/s11842-012-9196-0

Ndayambaje JD, Heijman WJM, Mohren GMJ (2013) Farm woodlots in rural Rwanda: Purposes and determinants. Agrofor Syst 87(4):797–814. https://doi.org/10.1007/s10457-013-9597-x

Neupane RP, Sharma KR, Thapa GB (2002) Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. Agric Syst 72:177–196. https://doi.org/10.1016/S0308-521X(01)00066-X

Pantera A, Mosquera-Losada MR, Herzog F, Den Herder M (2021) Agroforestry and the environment. Agrofor Syst 95(5):767–774. https://doi.org/10.1007/s10457-021-00640-8

Pattanayak SK, Mercer DE, Sills E, Yang JC (2003) Taking stock of agroforestry adoption studies. Agrofor Syst. https://doi.org/10.1023/A:1024809108210

Pompeu GDSS, Rosa LS, Modesto RS, Vieira TA (2012) Adoption of agroforestry systems by smallholders in Brazilian Amazon. Trop Subtrop Agroecosyst. *15*(1).

Prokopy LS, Floress K, Arbuckle JG, Church SP, Eanes FR, Gao Y, Gramig BM, Ranjan P, Singh AS (2019) Adoption of agricultural conservation practices in the United States: evidence from 35 years of quantitative literature. J Soil Water Conserv 74(5):520–534. https://doi.org/10.2489/jswc.74.5.520

Rajasekharan P, Veeraputhran S (2002) Adoption of intercropping in rubber smallholdings in Kerala, India: a tobit

analysis. Agrofor Syst 56(1):1–11. https://doi.org/10.1023/A:1021199928069
Ranjan P, Arbuckle JG, Church SP, Eanes FR, Floress K, Gao Y, Gramig BM, Singh AS, Prokopy LS (2022) Understanding the relationship between land tenure and conservation behavior: recommendations for social science research. Land Use Policy 120:106161. https://doi.org/10.1016/j.landusepol.2022.106161
Ruheza S, Tryphone GM, Mbwambo JS, Khamis ZK, Swella GB, Mushobozy DM (2012) Studies on the influence of tree tenure on the adoption of agroforestry practices in Uluguru Mountains, Tanzania. International Research Journal of Agricultural Science and Soil Science 2:170–178
Scoones I (1998). Sustainable rural livelihoods: a framework for analysis, IDS working paper 72, Brighton: IDS. https://www.staff.ncl.ac.uk/david.harvey/AEF806/Sconnes1998.pdf.
Silao ZH, Ocloo XS, Chapman M, Hunt L, Stenger K (2023) Trends in agroforestry research over 4 decades. Elem Sci Anth 11:1–19. https://doi.org/10.1525/elementa.2022.00151
Sinclair FL (1999) A general classification of agroforestry practice. Agrofor Syst 46:161–180. https://doi.org/10.1023/A:1006278928088
Smith MM, Bentrup G, Kellerman T, MacFarland K, Straight R, Ameyaw L (2021) Windbreaks in the United States: a systematic review of producer-reported benefits, challenges, management activities and drivers of adoption. Agric Syst 187:103032. https://doi.org/10.1016/j.agsy.2020.103032
Smith MM, Bentrup G, Kellerman T, MacFarland K, Straight R, Ameyaw L, Stein S (2022a) Silvopasture in the USA: a systematic review of natural resource professional and producer-reported benefits, challenges, and management activities. Agric Ecosyst Environ 326:107818. https://doi.org/10.1016/j.agee.2021.107818
Smith MM, Bentrup G, Kellerman T, MacFarland K, Straight R, Ameyaw L (2022b) Agroforestry extent in the United States: a review of national datasets and inventory efforts. Agriculture 12(5):726. https://doi.org/10.3390/agriculture12050726
Sood KK, Mitchell CP (2009) Identifying important biophysical and social determinants of on-farm tree growing in subsistence-based traditional agroforestry systems. Agrofor Syst 75(2):175–187. https://doi.org/10.1007/s10457-008-9180-z
StataCorp (2023) Stata statistical software: release 18. StataCorp LLC, College Station, TX
Toth GG, Ramachandran Nair PK, Jacobson M, Widyaningsih Y, Duffy CP (2017) Malawi's energy needs and agroforestry: adoption potential of woodlots. Hum Ecol 45(6):735–746. https://doi.org/10.1007/s10745-017-9944-z
United Nations Development Programme. (2017). Application of the sustainable livelihoods framework in development projects. Retrieved 05 Jan 2026 from https://www.undp.org/sites/g/files/zskgke326/files/migration/latinamerica/UNDP_RBLAC_Livelihoods-Guidance-Note_EN-210July2017.pdf.
USDA/NASS (2024) 2022 Census of agriculture. United States Department of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2022/index.php#full_report
Vevea JL, Coburn K, Sutton A (2019) Publication bias. In: Cooper H, Hedgers LV, Valentine JC (eds.) The handbook of research synthesis and meta-analysis. pp 383–430. Russell Sage Foundation. https://doi-org.proxy.mul.missouri.edu/https://doi.org/10.7758/9781610448864.21.
Yeganeh AJ, McCoy AP, Schenk T (2020) Determinants of climate change policy adoption: a meta-analysis. Urban Clim 31:100547. https://doi.org/10.1016/j.uclim.2019.100547
Zabala A, Pascual U, García-Barrios LE, Mukherjee N (2025) Drivers to adopt agroforestry and sustainable land-use innovations: a review and framework for policy. Land Use Policy 151:107468
Zerihun MF, Muchie M, Worku Z (2014) Determinants of agroforestry technology adoption in Eastern Cape province, South Africa. Dev Stud Res 1(1):382–394. https://doi.org/10.1080/21665095.2014.977454