

Comparing Perceived Preferences and Feasibility of Different Silvicultural Practices for Increasing Forest Carbon Stocks in Georgia, United States

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Forest management practices affect stored carbon stocks differently. Therefore, understanding the mismatch between stakeholder groups' preferences for forest management practices and the likelihood of their adoption can highlight areas where socioeconomic externalities should be addressed. In addition to preference–feasibility gaps at the individual level, low participation in forest carbon programs can also reflect broader structural and economic constraints (e.g., monitoring/verification and transaction costs, aggregation/minimum-acreage requirements, contract duration/permanence requirements, and carbon price uncertainty). This study used the Analytical Hierarchy Process to explore stakeholder preferences for six forest management practices to increase carbon stocks in Georgia, USA, and compared them with their perceived feasibility. The results showed that increasing the capacity for sustainable forest management, using biochar and afforestation, can enhance the potential to increase carbon stocks, as their preference was higher than their perceived feasibility. Increasing awareness of the potential of conservation and longer rotation ages, which are more feasible but less preferred, will help improve stakeholder preferences and further increase their adoption. Priorities differed between men and women; however, gender-based comparisons are interpreted as exploratory, given the limited number of women respondents. These findings can benefit forest carbon program managers, landowners, and policymakers. Given the small, workshop-based sample, the findings should be interpreted as a pilot assessment intended to inform larger follow-on studies.

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INTRODUCTION

Climate change is a pressing global challenge that has significant implications for the health of our planet and the well-being of future generations. As one of the main drivers of climate change and global warming, in particular, the release of greenhouse gases, specifically carbon dioxide (CO₂), into the atmosphere has been a major focus of research and policy efforts (IPCC 2018). Based on the United States Environmental Protection Agency's (USEPA) *Inventory of U.S. Greenhouse Gas Emissions* data, the gross total

emissions nationwide were 6,025 million metric tons CO₂ equivalents in 2020, out of which Georgia accounted for 140 million metric tons CO₂ equivalents (EPA 2023). Forestry activities could become a significant method for sequestering (and storing) carbon at a large scale and at a relatively low cost (Galik *et al.* 2009). The carbon stock in US forests in 2021 was estimated to be 61.0 billion metric tons (Hoover and Riddle 2022). Forest ecosystem pools accounted for 96% of the stored carbon, while the remaining carbon was stored in the product pool, which includes harvested wood products. Within Georgia, the contribution of forest-related carbon sinks in relation to the total emissions has increased from 21.5% in 2001 to 31.5% in 2020 (EPA 2023). Moreover, forest-related carbon sink is the largest among all the land-use categories (Fig. 1).

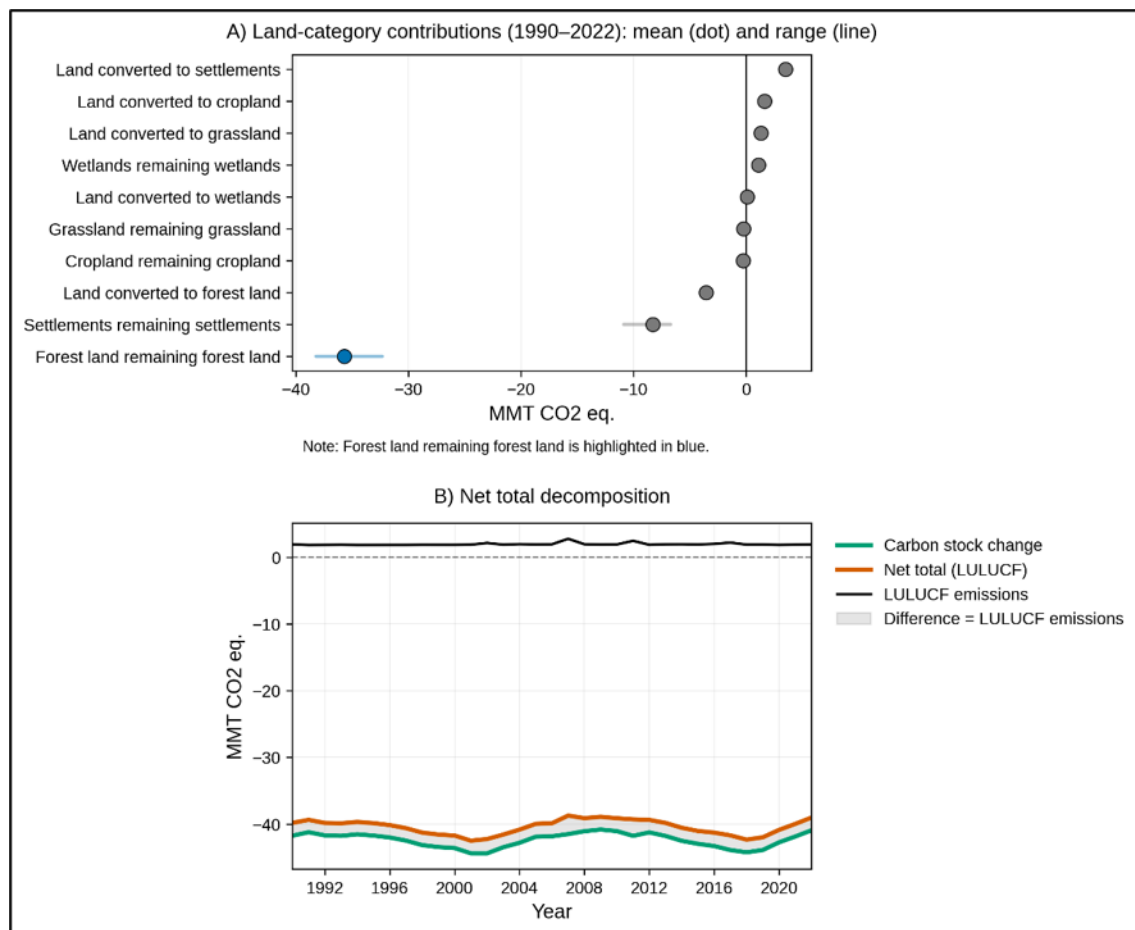


Fig. 1. Georgia's land use, land-use change, and forestry (LULUCF) carbon dynamics for years 1990–2022. Panel A summarizes land-category contributions (mean and range) to show that forest land remaining forest land is the dominant sink (highlighted in blue). Panel B decomposes net total over the years; net total includes the carbon stock change (Net total = LULUCF emissions + carbon stock change) (EPA 2023).

The role of forestry as a carbon sink can be further increased by adopting several options. Different practices, such as afforestation, reforestation, forest thinning, biodiversity conservation, and sustainable logging, can have varying impacts on carbon stocks (Ryan *et al.* 2010; Ameray *et al.* 2021). Nielsen *et al.* (2014) found that afforestation would sequester around 200 million metric tons of carbon annually at a carbon price of \$50/metric ton in the contiguous US, with an additional 100 million metric tons of carbon

sequestered each year at \$100/metric ton. Keyser and Zarnoch (2012) found that unthinned stands showed a slower rate of accumulated aboveground tree carbon stocks of around 40% from 1975 to 2005 in the southern Appalachians, compared to sustainably thinned stands, which had a net rate of 125% (excluding ingrowth) and 148% (including ingrowth) over the same period. Furthermore, strategic planning of forestry and conservation activities that generate biodiversity and carbon gains is possible to maintain ecosystem integrity (*Law et al.* 2022).

Despite the substantial proportion of private forests in the US, accounting for 59.7% of the total forestland area (*Butler et al.* 2021), private forest owners have shown very low participation in carbon sequestration programs, with less than 0.1% of family forest landowners enrolled with 400,000 ha of forestland (*Sass et al.* 2022). This is noteworthy, considering the increasing demand for alternative revenue streams to support the sustainability of these lands (*Charnley et al.* 2010). This concerning trend is particularly significant considering the imperative to achieve large-scale implementation and effective governance of carbon removal strategies to meet the global climate target of staying below 2 °C (IPCC 2018).

There are several factors that may limit the implementation of sustainable forestry techniques to increase carbon stocks, even though landowners might prefer them. *Nielsen and Rice* (2004) identified the rate of change in timber prices over time, the growth rate of commercial tree species, and the discount rate as some of the factors that may pose a challenge to the wider adoption of these practices in relation to conventional logging practices. They argue that if these ecologically sound practices are considered socially desirable, steps should be taken to enhance their financial viability and promote their widespread adoption. On the other hand, the desirability or preference for these practices is governed by forest use history, the condition of the forest, and socio-cultural values and beliefs regarding the management goals of the landowners (*Berninger et al.* 2010).

Some studies have analyzed the likelihood of forest landowners participating in carbon markets. *Fletcher et al.* (2009) found that forest landowners strongly prefer higher payments, no withdrawal penalty, and, surprisingly, longer time commitments, which can increase the likelihood of selling forest carbon credits. *Alhassan et al.* (2019) indicate that forest landowners who prioritize forest ecosystem preservation are more likely to participate in carbon markets, and those who trust information about climate change from scientists or the government are more willing to participate compared to those who do not. In the southern US, among different groups of forest landowners, those with recreational goals for their property were most likely to participate in carbon sequestration, with management changes (such as a written plan and verification requirements) and carbon revenue being the two key determinants influencing their probability of participation (*Khanal et al.* 2017). More broadly, the voluntary carbon market context – including uncertainty in carbon pricing and liquidity – can affect landowner expectations about program value and risk (*Proton* 2025).

The theory of planned behavior states that behavior is a function of attitudes, subjective norms, and perceived behavioral control (*La Barbera and Ajzen* 2021). The attitude towards behavior refers to an individual's subjective assessment (preference), either positive or negative, of a particular behavior. On the other hand, the likelihood of adoption of a forest management practice is characterized by perceived behavioral control, which refers to the individual's self-assessment of the ease or difficulty in performing a particular action (*e.g.*, limitations felt by an individual) (*Karppinen and Berghäll* 2015). Exploring the mismatch between the preferences of stakeholder groups for forest

management practices in the context of carbon and their likelihood of adoption can illuminate where market and policy externalities need to be resolved (Choi 1994). In this study, the authors operationalize TPB using attitudes (preferences) and perceived behavioral control (feasibility), but there is no direct measure of subjective norms, a limitation we acknowledge.

When the preference exceeds perceived feasibility, improving capacity for such practices can help increase their potential to increase carbon stocks in Georgia. On the other hand, when perceived feasibility exceeds preferences, raising awareness of the potential of these practices to increase carbon stocks will strengthen their appeal and further aid their adoption. Importantly, “feasibility” can be shaped by policy instruments that reduce up-front costs and informational burdens (*e.g.*, cost-share offered under various federal and state conservation programs, such as the Conservation Reserve Program and/or Environmental Quality Incentives Program) (US Department of Agriculture, USDA 2026).

As far as the authors know, there are no studies that have compared ‘which practices landowners think are best’ with ‘which practices landowners are likely to adopt.’ The objective of this research was to compare perceived preferences for implementing a forest management practice to increase carbon stock with its perceived feasibility, specifically to identify potential trade-offs between the environmental benefits of the practice in relation to its perceived practicality.

This study is relevant in the context of Georgia, as private forest landownership accounts for 89% of the total forest area (9.9 million hectares). This is much higher than the national average. Almost 54.3% of total forestland amounting to 5.3 million ha is owned by 130.9 thousand family forest landowners (Butler *et al.* 2021) who are looking for alternate markets for forest-based ecosystem services for improving their cash flows. Out of these, fewer than 1000 family forest landowners participate in carbon sequestration programs in Georgia, with a total of a mere 45,000 ha (Butler *et al.* 2021). Because Georgia has an exceptionally high proportion of privately owned forests, the analysis is to be interpreted as an explicitly Georgia-focused pilot case study intended to inform broader, more representative future research.

METHODS

Two workshops were conducted in Georgia to assess the perception of forest landowners regarding the potential of different forest management practices to increase carbon stocks. The first workshop was held on October 14, 2022. At the end of the workshop, which included presentations on forest carbon programs and carbon markets, the participants were asked to list all the forest management practices that they considered important for increasing carbon stocks, write pros and cons for each, and then rank them in terms of their potential.

A second survey was conducted during a workshop held on February 10, 2023, which also focused on forest carbon programs and carbon markets in the US South. At the end of the workshop, the workshop participants were asked to fill out a survey document with their responses. The survey was designed to evaluate the potential of six forest management practices to increase carbon stocks, identified as the most important from the first workshop survey. A different set of participants was recruited for this workshop than for the first one (*i.e.*, no repeat attendees were targeted); however, participation was voluntary, so the sample may reflect self-selection (*e.g.*, attendees may be more interested

in carbon programs than the broader population). The survey consisted of three sections: write-in pros and cons of the six forest management practices, adoption likelihood of the practices, and a pairwise comparison of which of the practices were important to the respondents (on a scale of very important, important, moderately important, and equally important) using the Analytic Hierarchy Process (AHP). Participants were asked to rate their likelihood of adopting the practices on their forestland on a scale of 1 (not sure) to 10 (most definitely).

Workshop participation and respondent characteristics (Table 1)

The first workshop had 16 participants. The second workshop had 23 participants; of these, 17 were men, 6 were women, and 19 were landowners, while 4 were non-landowners. All 23 respondents completed the AHP pairwise comparisons and the adoption-likelihood ratings; responses to the open-ended “pros and cons” items were fewer than 23 because not all respondents answered them. Because of the small sample size (and gender imbalance), results – especially subgroup comparisons – should be interpreted cautiously and as exploratory.

Table 1. Workshop Participation and Survey Respondent Characteristics

Item	Workshop 1 (Oct 14, 2022)	Workshop 2 (Feb 10, 2023)
<i>Total participants</i>	16	23
<i>Survey instrument used in analysis</i>	Practice listing, pros/cons, ranking	AHP pairwise comparisons, adoption-likelihood ratings, pros/cons
<i>Men</i>	Not collected	17
<i>Women</i>	Not collected	6
<i>Landowners</i>	Not collected	19
<i>Non-landowners</i>	Not collected	4

The first workshop participants identified and ranked 17 forest management practices important to them for increasing carbon stocks in Georgia. More than one respondent identified the top six ranked practices of a) longer rotation age (waiting longer to harvest trees), b) afforestation (establishing a forest on land not previously forested), c) advanced genetics (planting genetically advanced species, *e.g.*, mass control pollinated or varietal/clone seedlings), d) sustainable forest management (optimal use of fertilizers, use of herbicides, prescribed burn, *etc.*), e) use of biochar, and f) conservation and carbon (enhancing carbon while improving habitat through activities such as planting or retaining native species).

Analytical Hierarchical Process

AHP is a multi-criteria decision-making method that helps to evaluate and prioritize alternatives based on multiple criteria. The AHP methodology was developed by Thomas L. Saaty in the late 1970s and has since been widely adopted by researchers and practitioners (Saaty 1987). It is widely used in decision-making across various fields, including environmental management, where it can help evaluate the potential environmental impacts of different alternatives and prioritize them accordingly (Joshi *et al.* 2018; Miner *et al.* 2021). The AHP methodology is based on a pairwise comparison of criteria and alternatives. It is a structured approach that involves breaking down a complex

decision problem into a hierarchy of criteria, sub-criteria, and alternatives. The hierarchy is represented graphically, with the top-level criteria being the main decision objectives and the lower levels representing sub-criteria and alternatives.

A pairwise comparison matrix was developed based on responses from workshop participants. This matrix was used to evaluate the relative importance of each forest management practice and alternative. The matrix was created by comparing each practice and alternative with all others at the same level of the hierarchy. The pairwise comparisons can be represented using a reciprocal matrix in which the relative weights are denoted as α_{ij} , and the reciprocal ($1/\alpha_{ij}$) is assigned to the opposite side of the diagonal. In the matrix below, the matrix element and weights are represented as α_{ij} and w .

$$A = (\alpha_{ij}) = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \dots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \dots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \dots & \frac{w_n}{w_n} \end{pmatrix} \quad (1)$$

To determine the relative weights of each practice, the geometric means of all pairwise comparisons (α_{ij} being very important as 7, important as 5, moderately important as 3, and equally important as 1) was calculated. We each geometric mean was divided by the sum of its column to get the final reciprocal matrix. The overall score for each practice was calculated as the average across rows. The matrix in Eq. 1 can be further represented as an identity matrix of size n .

$$W(A - n \times I) = 0 \quad (2)$$

The value of n in Eq. 2 is also the largest eigenvalue or trace of matrix A , also known as λ_{max} . The identity matrix ensures that λ_{max} equals n , which is a necessary condition for confirming consistency. If there are varying responses in the pairwise comparisons, inconsistency could arise, which would cause λ_{max} to deviate from n . The consistency of the matrix is as follows.

$$CI = (\lambda_{max} - n)/(n - 1) \quad (3)$$

Here CI is the consistency index. The consistency ratio (CR) is calculated by the following:

$$CR = CI/RI \quad (4)$$

Here RI is the random index as designated by Saaty (1987). It is created from a random matrix of order n (in this case, 6). Saaty (1987) states that a CR of less than 10% is required to confirm consistency. A large sample size is not necessary for conducting AHP, making it a cost-effective method for obtaining the intrinsic motivations of survey respondents. However, while AHP can be applied with small n , the small, workshop-based sample limits statistical generalizability to all Georgia family forest landowners, and results should therefore be interpreted as exploratory.

The AHP method uses a mathematical algorithm to calculate the overall scores of each alternative based on the relative importance of each criterion and the pairwise

comparison results. It provides a more comprehensive and structured approach to evaluating and comparing alternatives based on multiple criteria, considering the trade-offs and preferences of the respondents (Saaty 1987). It allows for a more robust analysis of the relative preference of different forest management practices. Interpreting the average likelihood of respondents adopting a particular forest management practice would provide insights into the perceived feasibility of each practice, based on the respondents' self-reported likelihood of adoption.

RESULTS AND DISCUSSION

Figure 2 shows the overall scores using AHP in relation to the average likelihood of adopting the six forest management practices. 'Sustainable forest management' was found to be the top preference. The hierarchy of preferences for other forest management practices was as follows: 'conservation and carbon' (second preference), 'advanced genetics' (third preference), use of biochar (fourth preference), afforestation (fifth preference), and longer rotation age (last preference).

Regarding the likelihood of adopting these forest management practices, respondents put conservation at the top, followed by sustainable forest management. The prominence of the two practices at the top in both preference and perceived feasibility could be due to the added ecosystem service benefits of each of the two practices (Phelps *et al.* 2012). Indeed, these were written as pros by 6 out of 19 for sustainable forest management and by 12 out of 17 respondents for conservation, respectively (Table 1).

The use of advanced genetics and longer rotation age ranked third and fourth, respectively, in terms of likelihood of adoption. It is highly likely that cost and delayed returns may be the important factors that put these two practices after conservation and sustainable forest management, respectively. Previous studies have also identified these hurdles to adopting these practices (Cubbage *et al.* 2005; Sathaye *et al.* 2006; Asante 2011). Moreover, these were written as the 'cons' by 7 out of 18 respondents for the use of advanced genetics and by 14 out of 21 respondents for longer rotation age (Table 2).

Table 2. Top Advantages (Pros) and Disadvantages (Cons) of Five Forest Management Practices Concerning Carbon as Reported by Respondents in the Second Georgia Workshop

Forest Management Practice	Top Pros	Top Cons
Afforestation	Stabilize soils; Increase additionality; Increase in urban green spaces; Good for carbon credits	Loss of agricultural land; Cost; Lowers land value
Advanced genetics	Improved growth timelines; Improved products	Cost; Unknown long-term effects; Decreased biodiversity value
Conservation & carbon	Increased biodiversity and habitat; Good for long-term ecosystem growth; Environmental and social value, Good stewardship	Reduced profit

Sustainable forest management	Improves ecosystem and habitats; Healthier trees; Better yield	Cost; Possible deleterious effects of herbicides; Risk of fire
Longer rotation age	Increased compatibility with carbon programs; Increased tonnage; Aesthetics	Delayed thinning returns; Mills cannot always take larger trees; Increase risk of disease, storms, and fire
Use of Biochar	Soil improvements; Increase income and better growth; More environment friendly	Expensive; Difficult to apply and obtain; New technology; Lack of available information

Note: Definitions and assumptions – Afforestation in this study refers to establishing forest on non-forest land within a landowner's holdings (e.g., pasture/cropland), and one does not assume that permanently developed land uses (e.g., residential/commercial) would be reversed. "Conservation and carbon" refers to habitat- and biodiversity-oriented management intended to enhance carbon while improving habitat (e.g., planting/retaining native species, buffers, and – where applicable – conservation easements). Conservation actions can be compatible with, and implemented alongside, other management choices (e.g., longer rotations, sustainable forest management), rather than representing a mutually exclusive option.

The use of biochar and afforestation came as the fifth and sixth priorities for the likelihood of adoption, respectively. This may be related to a lack of knowledge of implementing new technology and loss of farming land, respectively. Previous research has also found these factors important for adopting biochar and afforestation (Latawiec *et al.* 2017; Ryan *et al.* 2018). These hurdles were mentioned in the cons by 8 out of 15 respondents for the use of biochar and by 10 out of 16 respondents for afforestation (Table 2).

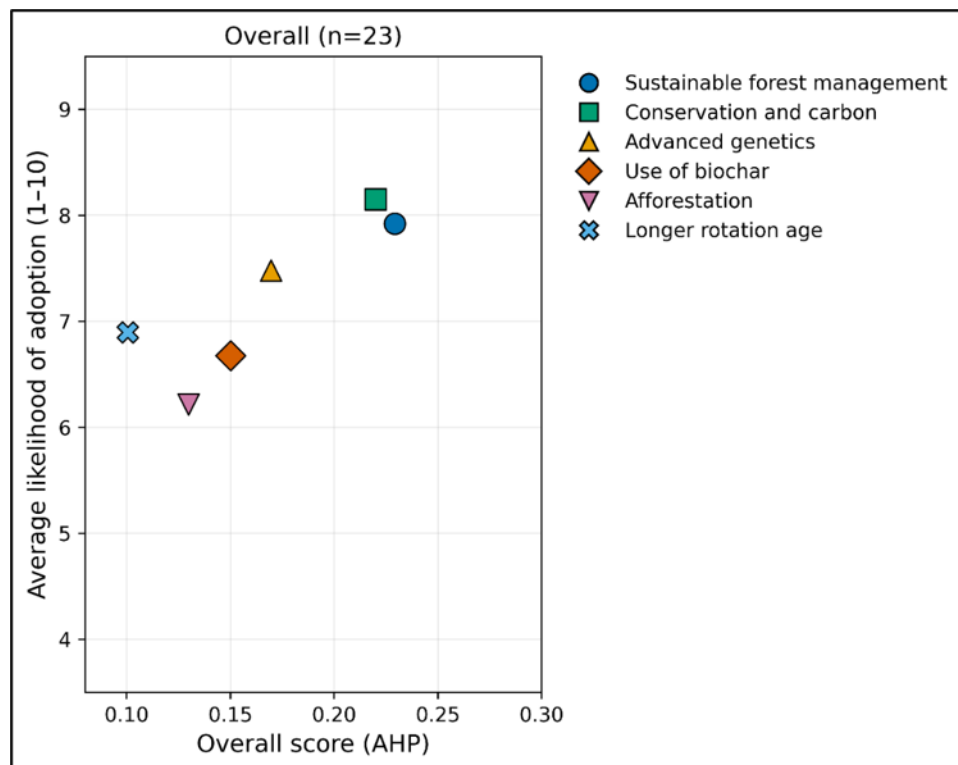


Fig. 2. The average likelihood of adopting a forest management practice in comparison with overall score received through AHP survey respondents

Sustainable forest management was the most preferred, but conservation was the most feasible practice according to the respondents. Cost may be one of the important factors in this divergence between preference and feasibility. Most respondents (10 out of 14) clearly mentioned this in their cons for sustainable forest management, while a high number of them (7 out of 16) noted that ‘conservation and carbon’ had no cons. Use of advanced genetics was given the same priority level (three) for both preference and feasibility. Interestingly, longer rotation age was perceived as the most feasible option, even though preference-wise, respondents would prefer biochar and afforestation over it. This could be due to the cons associated with the implementation of biochar and afforestation as well as due to the pros of longer rotation leading to higher carbon stocks and stronger trees.

To add quantitative context to the “cost” barrier (raised qualitatively by respondents), recent southern forestry practice cost summaries report overall average costs (per acre) of approximately \$159.8 for mechanical site preparation, \$37.8 for prescribed burning, \$101.7 for chemical application, and \$114.2 for fertilization (Maggard *et al.* 2025). For biochar, a recent biochar carbon market analysis used an application scenario of \$240 per ton with four tons applied per acre every five years (Elias *et al.* 2022), illustrating why respondents may perceive biochar as expensive and difficult to adopt without market revenue or support. These values provide context (they are not direct observations from our workshops), but they help clarify why up-front costs can reduce perceived feasibility. Incentive mechanisms that reduce up-front costs and transaction burdens (e.g., cost-share/technical assistance through federal and state conservation programs; aggregation and simplified monitoring/verification) are plausible levers to narrow preference–feasibility gaps (US Department of Agriculture 2026; White *et al.* 2018).

Figure 3 shows the breakdown of AHP scores and the likelihood of adoption between men and women. Conservation seems preferable and feasible to women as an option to increase carbon sequestration over sustainable forest management, while it is the other way around for men. Women were more likely to adopt biochar, while men see higher feasibility in using advanced genetics, longer rotation ages, and afforestation. In fact, women preferred use of biochar (score = 0.195) even over sustainable forest management (score = 0.191), albeit very narrowly. Women preferred afforestation over longer rotation ages and advanced genetics but were likely to adopt it the least. Because only 6 women participated in the second workshop, these gender comparisons are exploratory and may be sensitive to individual responses.

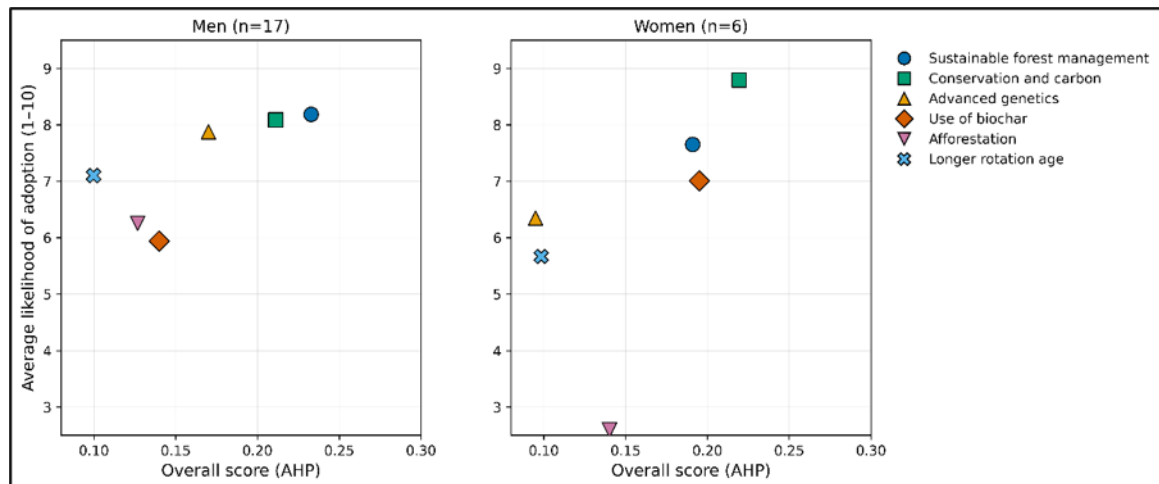


Fig. 3. Comparing responses between (a) men and (b) women regarding the average likelihood of adopting a forest management practice in relation to the overall score received through AHP

Figure 4 shows the breakdown of AHP scores and the likelihood of adoption between those who own land and those who don't. Landowners saw higher feasibility in adopting 'conservation and carbon' over sustainable forest management as opposed to non-landowners, even though their preference for sustainable forest management was just slightly higher (scores: 0.212 vs 0.210). These were followed using advanced genetics and biochar, both in preference and feasibility for the landowners. Their least preferred option was a longer rotation age, but its feasibility was higher than that of afforestation. The preferences of the overall respondents matched those of landowners, but in terms of feasibility, there was a divergence: landowners were more likely to adopt biochar at longer rotation ages. Preference and feasibility for non-landowners for sustainable forest management were the highest. Their preference for conservation was higher than for advanced genetics, but feasibility was the opposite. The preference and feasibility of longer rotation age, afforestation, and use of biochar followed sequentially after that.

The present results regarding gendered aspects of carbon-related forest management practices (conservation vs sustainable forest management) are consistent with Brenner *et al.* (2013), who noted that females have a greater interest in conservation easements. The idea that women are more environmentally conscious is supported by several studies, including Davidson and Freudenburg (1996). Welsh *et al.* (2018) also found that female landowners were more likely than men to participate in the Wetland Reserve Program without compensation. It is interesting that the present survey found women strongly preferring biochar. This finding needs to be explored further through research and extension to develop the biochar market further. All the women who filled-in the surveys were landowners, which might explain why afforestation was the least feasible option for them (with the possible reason of loss of land available for farming). This also applies to landowners' results, on the whole, who found it the least feasible option. Given the small number of women respondents, these patterns should be treated as suggestive rather than generalizable.

The preference of the overall respondents matched that of landowners. In terms of perceived feasibility, there was a divergence: landowners were more likely to adopt biochar with longer rotation ages. Landowner *versus* non-landowner perceptions of preference and feasibility showed the diversity of stakeholder views and should be used at different stages of program and policy development, because even though landowners are the ones to

implement things on the ground, the general social preferences do influence feasibility (Wisdom *et al.* 2014). Despite these recommendations, the pros and cons of each practice need to be considered at all times.

It is important to note that the recommendations from this study for capacity building and awareness raising for forestry practices are relevant. There was no ‘best practice’ found, but these results can certainly guide investment in the two. The present findings that conservation is more feasible than sustainable forest management in increasing carbon stocks can be useful in building collaborations with federal and state conservation programs (USDA 2023). Finally, the ‘market and policy externalities’ that can contribute to preference–feasibility gaps include program transaction costs (*e.g.*, enrollment and contracting), monitoring/verification burdens, requirements related to additionality and permanence, and uncertainty in carbon credit pricing and market liquidity (Procton 2025; White *et al.* 2018).

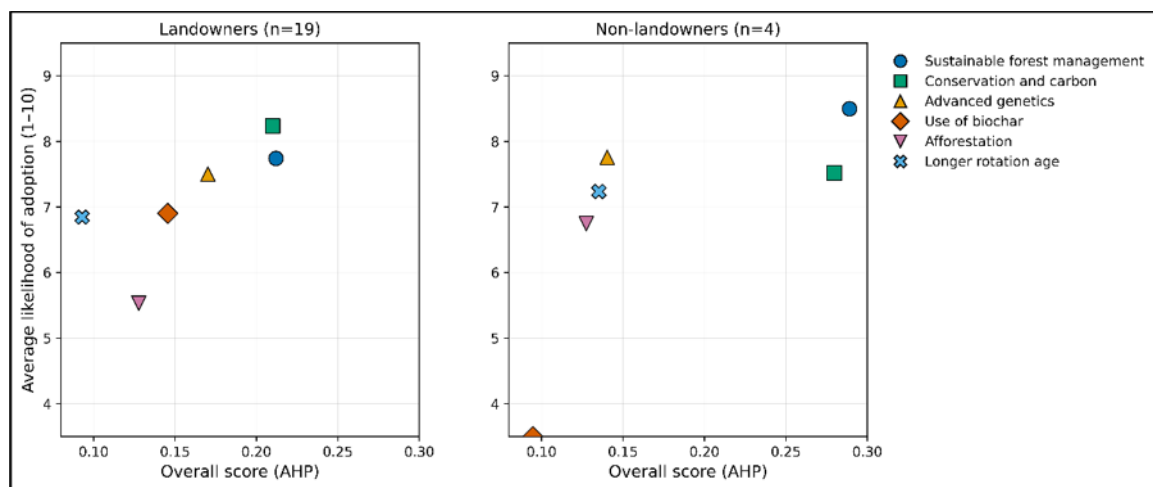


Fig. 4. Comparing responses regarding the average likelihood of adopting a forest management practice in relation to the overall score received through the AHP between (a) those who own land and (b) those that do not

Limitations and Future Research

The use of the AHP method is robust and helped to generalize the findings of this study. Nevertheless, this research was limited to two workshops in Georgia and needs to be replicated across the US South, where the percentage of private landowners is high. It can, however, be a good example of a case study in this region. It was also recognized that the small sample size was a limitation, and the specific results of this study might not apply globally. The TPB behavior considers attitudes and perceived behavioral controls, but it does not account for the influence of socio-cultural and economic norms. Future research can delve deeper into this and design a more comprehensive study to explore the relevance of norms to preference and feasibility. Conducting surveys and ethnographic studies are among the ways this can be done. In addition, the disparities that were discovered between adoption and preferences could be attributed, in part, to differences in communitarian *versus* individualistic preferences (Froebel *et al.* 1981; Okereke 2018). This can include perceptions about who (an individual, a group, or a governing body) should be accountable for investing in the provision of ecosystem services, such as carbon. This is another limitation of this study, as the data collected does not include these factors.

Furthermore, Georgia's exceptionally high share of privately owned forests likely amplifies heterogeneity in management objectives and increases coordination/transaction costs for program participation, which may shape perceived feasibility. Accordingly, the study should be regarded as a Georgia-focused pilot investigation intended to inform more comprehensive future research, and findings should be interpreted with appropriate caution. Additionally, because both workshops focused on forest carbon programs and carbon markets and participation was voluntary, self-selection may bias the sample toward individuals with a higher baseline interest in carbon-related practices. Finally, although TPB includes subjective norms, the present data collection did not directly measure norms; the absence of norm measures (and the absence of qualitative/ethnographic approaches that could surface them) may bias inference about motivations underlying preference and feasibility.

Nevertheless, it is hoped that this study and its findings will be beneficial to both landowners and managers of forest carbon programs as well as to policymakers at large.

CONCLUSIONS

1. This study compared the perceived potential trade-offs between the benefits of six different forest management practices in relation to their perceived feasibility. The implications of the differences between the two, with recommendations on how carbon programs, policies, and initiatives can be improved, were also discussed.
2. It was found that, overall, improving capacity for sustainable forest management (most preferred but second in feasibility), the use of biochar (fourth in preference but fifth in feasibility) and afforestation (fifth in preference but last in feasibility) can help enhance their potential to increase carbon stocks.
3. For men, improving capacity for afforestation (second preferred but fourth in feasibility) and the use of biochar (fourth in preference but least likely to be adopted) are important. At the same time, this is also the case for afforestation (the fourth preferred but least likely to be adopted) for women. Given the limited number of women respondents, we report gender-based conclusions to be explicitly exploratory: in our sample, women showed higher preference/feasibility for conservation relative to sustainable forest management and higher preference for biochar, but these patterns should be tested in larger, more gender-balanced samples before making general statements. Furthermore, increasing awareness of the potential of conservation (second in preference but top in feasibility) and longer rotation ages (least preferred but fourth in feasibility) to increase carbon stocks will improve their preference among stakeholder groups and further aid their adoption. This is also applicable to the use of advanced genetics for both men (fifth preference but third in feasibility) and women (least preferred but fourth in feasibility). Understanding the differences between men's and women's perceptions will help target capacity-building and awareness-raising for practices.
4. Ultimately, by separating what stakeholders value from what they believe they can realistically implement, results of the study provide a practical diagnostic for redesigning forest-carbon efforts so that interest can be translated into durable, on-the-ground action. The results will streamline the current strategies to increase the

participation of rural landowners in growing voluntary carbon markets by offering better-suited products.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Use of Generative AI

Generative AI was not used to prepare images, figures, graphs, or diagrams; Grammarly was used only to check for grammatical correctness.

REFERENCES CITED

- Alhassan, M., Motallebi, M., and Song, B. (2019). "South Carolina forestland owners' willingness to accept compensations for carbon sequestration," *Forest Ecosystems* 6(1). <https://doi.org/10.1186/s40663-019-0175-1>
- Ameray, A., Bergeron, Y., Valeria, O., Montoro Girona, M., and Cavard, X. (2021). "Forest carbon management: A review of silvicultural practices and management strategies across boreal, temperate and tropical forests," *Current Forestry Reports*, Springer Science and Business Media Deutschland GmbH 7(4), 245-266. <https://doi.org/10.1007/s40725-021-00151-w>
- Asante, P. (2011). *Carbon Sequestration and the Optimal Economic Harvest Decision*, University of Alberta.
- Berninger, K., Adamowicz, W., Kneeshaw, D., and Messier, C. (2010). "Sustainable forest management preferences of interest groups in three regions with different levels of industrial forestry: An exploratory attribute-based choice experiment," *Environmental Management* 46(1), 117-133. <https://doi.org/10.1007/s00267-010-9507-1>
- Brenner, J. C., Lavallato, S., Cherry, M., and Hileman, E. (2013). "Land use determines interest in conservation easements among private landowners," *Land Use Policy* 35, 24-32. <https://doi.org/10.1016/J.LANDUSEPOL.2013.03.006>
- Butler, B. J., Butler, S. M., Caputo, J., Dias, J., Robillard, A., and Sass, E. M. (2021). "Family forest ownerships of the United States, 2018: Results from the USDA Forest Service, National Woodland Owner Survey," Gen. Tech. Rep. NRS-199. Madison,

- WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 52 pp. [plus 4 appendixes], 199. <https://doi.org/10.2737/NRS-GTR-199>
- Charnley, S., Diaz, D., and Gosnell, H. (2010). "Mitigating climate change through small-scale forestry in the USA: Opportunities and challenges," *Small-scale Forestry* 9(4), 445-462. <https://doi.org/10.1007/s11842-010-9135-x>
- Choi, J. P. (1994). "Irreversible choice of uncertain technologies with network externalities," *The RAND Journal of Economics* 25(3), article 382. <https://doi.org/10.2307/2555768>
- Cubbage, F. W., Wear, D. N., and Bennadji, Z. (2005). "Economic prospects and policy framework of forest biotechnology in the Southern U.S.A. and South America," in: *Managing Forest Ecosystems: Landscapes, Genomics and Transgenic Conifers*, Ch. 11, Vol. 9, pp. 191-207.
- Davidson, D. J., and Freudenburg, W. R. (1996). "Gender and environmental risk concerns," Sage Publications, Sage CA: Thousand Oaks, CA, 28(3), 302-339. <https://doi.org/10.1177/0013916596283003>
- Elias, M., Hunt, J., Remucal, J., Saksa, P., and Sanchez, D. L. (2022). "Biochar carbon credit market analysis: Examining the potential for coupled biochar and carbon credit production from wildfire fuel reduction projects in the Western U.S.," *Blue Forest Conservation*.
- EPA. (2023). "Inventory of U.S. Greenhouse Gas Emissions and Sinks | US EPA," <<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>> (Apr. 18, 2023).
- Fletcher, L. S., Kittredge, D., and Stevens, T. (2009). "Forest landowners' willingness to sell carbon credits: A pilot study," *Northern Journal of Applied Forestry* 6(1), 35-37. <https://doi.org/10.1093/NJAF/26.1.35>
- Froebel, F., Heinrichs, J., and Kreye, O. (1981). *The New International Division of Labour*, Cambridge Books, Cambridge University Press.
- Galik, C. S., Mobley, M. L., and de Richter, D. B. (2009). "A virtual 'field test' of forest management carbon offset protocols: The influence of accounting," *Mitigation and Adaptation Strategies for Global Change* 14(7), 677-690. <https://doi.org/10.1007/s11027-009-9190-9>
- Hoover, K., and Riddle, A. A. (2022). U.S. Forest Carbon Data: In Brief (R46313).
- IPCC. (2018). "Global warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change," <<https://www.ipcc.ch/sr15/>> (Mar. 17, 2023).
- Joshi, O., Parajuli, R., Kharel, G., Poudyal, N. C., and Taylor, E. (2018). "Stakeholder opinions on scientific forest management policy implementation in Nepal," *PLOS ONE* 13(9), article e0203106. <https://doi.org/10.1371/JOURNAL.PONE.0203106>
- Karppinen, H., and Berghäll, S. (2015). "Forest owners' stand improvement decisions: Applying the theory of planned behavior," *Forest Policy and Economics* 50, 275-284. <https://doi.org/10.1016/j.forpol.2014.09.009>
- Keyser, T. L., and Zarnoch, S. J. (2012). "Thinning, age, and site quality influence live tree carbon stocks in upland hardwood forests of the southern Appalachians," *Forest Science* 58(5), 407-418. <https://doi.org/10.5849/forsci.11-030>
- Khanal, P. N., Grebner, D. L., Munn, I. A., Grado, S. C., Grala, R. K., and Henderson, J. E. (2017). "Evaluating non-industrial private forest landowner willingness to manage

- for forest carbon sequestration in the southern United States,” *Forest Policy and Economics* 75, 112-119. <https://doi.org/10.1016/j.forpol.2016.07.004>
- La Barbera, F., and Ajzen, I. (2021). “Moderating role of perceived behavioral control in the theory of planned behavior: A preregistered study,” *Journal of Theoretical Social Psychology*, John Wiley & Sons, Ltd. 5(1), 35-45. <https://doi.org/10.1002/JTS5.83>
- Latawiec, A. E., Królczyk, J. B., Kuboń, M., Szwedziak, K., Drosik, A., Polańczyk, E., Grotkiewicz, K., and Strassburg, B. B. N. (2017). “Willingness to adopt biochar in agriculture: The producer’s perspective,” *Sustainability* 9(4), article 655. <https://doi.org/10.3390/SU9040655>
- Law, B. E., Moomaw, W. R., Hudiburg, T. W., Schlesinger, W. H., Stermann, J. D., and Woodwell, G. M. (2022). “Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States,” *Land* 11(5), article 721. <https://doi.org/10.3390/LAND11050721>
- Maggard, A., Murphy, H. E., and Pullalarevu, S. R. (2025). *Costs & Trends of Southern Forestry Practices 2024*, Alabama Cooperative Extension System.
- Miner, J., Dwivedi, P., Izlar, R., Atkins, D., and Kadam, P. (2021). “Perspectives of four stakeholder groups about the participation of female forest landowners in forest management in Georgia, United States,” *PLoS ONE* 16(8), e0256654. <https://doi.org/10.1371/journal.pone.0256654>
- Nielsen, A. S. E., Plantinga, A. J., and Alig, R. J. (2014). “Carbon sequestration through afforestation in the United States,” *USDA Forest Service - General Technical Report PNW-GTR*, 888(888 GTR), 1-35. <https://doi.org/10.2737/PNW-GTR-888>
- Nielsen, E., and Rice, R. (2004). “Sustainable forest management and conservation incentive agreements,” *International Forestry Review* 6(1), 56-60(5). <https://doi.org/10.1505/for.6.1.56.32065>
- Okereke, C. (2018). *Politics of the Environment: A Survey*, Routledge.
- Phelps, J., Webb, E. L., and Adams, W. M. (2012). “Biodiversity co-benefits of policies to reduce forest-carbon emissions,” *Nature Climate Change* 2(7), 497-503. <https://doi.org/10.1038/nclimate1462>
- Procton, A. (2025). *State of the Voluntary Carbon Market 2025: Meeting the Moment: Renewing Trust in Carbon Finance*, C. Barber, G. Bennett, and A. Peterson (eds.), Ecosystem Marketplace (a Forest Trends initiative).
- Ryan, M. G., Harmon, M. E., Birdsey, R. A., Giardina, C. P., Heath, L. S., Houghton, R. A., Jackson, R. B., McKinley, D. C., Morrison, J. F., Murray, B. C., Pataki, D. E., and Skog, K. E. (2010). “A synthesis of the science on forests and carbon for U.S. Forests,” *Ecological Society of America: Issues in Ecology* 13, 1-16.
- Ryan, M., O’Donoghue, C., and Hynes, S. (2018). “Heterogeneous economic and behavioural drivers of the Farm afforestation decision,” *Journal of Forest Economics* 33, 63-74. <https://doi.org/10.1016/J.JFE.2018.11.002>
- Saaty, R. W. (1987). “The analytic hierarchy process—what it is and how it is used,” *Mathematical Modelling* 9(3–5), 161-176. [https://doi.org/10.1016/0270-0255\(87\)90473-8](https://doi.org/10.1016/0270-0255(87)90473-8)
- Sass, E. M., Caputo, J., and Butler, B. J. (2022). *United States Family Forest Owners’ Awareness of and Participation in Carbon Sequestration Programs: Initial Findings from the USDA Forest Service National Woodland Owner Survey*, Forest Science, Oxford Academic, 68(5–6), 447-451. <https://doi.org/10.1093/FORSCI/FXAC026>
- Sathaye, J., Makundi, W., Dale, L., Chan, P., and Andrasko, K. (2006). “GHG mitigation potential, costs and benefits in global forests: A dynamic partial equilibrium

- approach,” *The Energy Journal* 27(Special Issue #3), 127-162.
<https://doi.org/10.5547/ISSN0195-6574-EJ-VOLSI2006-NOSI3-7>
- US Department of Agriculture. (2026). “Environmental Quality Incentives Program - Georgia | Natural Resources Conservation Service,”
<<https://www.nrcs.usda.gov/programs-initiatives/environmental-quality-incentives-program/georgia/environmental-quality>> (Feb. 16, 2026).
- USDA. (2023). “Conservation Reserve Program,” <<https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/>> (Apr. 17, 2023).
- Welsh, R., Webb, M. E., and Langen, T. A. (2018). “Factors affecting landowner enrollment in wetland restoration in northeastern New York State,” *Land Use Policy* 76, 679-685. <https://doi.org/10.1016/J.LANDUSEPOL.2018.02.051>
- White, A. E., Lutz, D. A., Howarth, R. B., and Soto, J. R. (2018). “Small-scale forestry and carbon offset markets: An empirical study of Vermont current use forest landowner willingness to accept carbon credit programs,” *PLOS ONE* 13(8), article e0201967. <https://doi.org/10.1371/journal.pone.0201967>
- Wisdom, J. P., Chor, K. H. B., Hoagwood, K. E., and Horwitz, S. M. (2014). “Innovation adoption: A review of theories and constructs,” *Administration and Policy in Mental Health* 41(4), 480. <https://doi.org/10.1007/S10488-013-0486-4>

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