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Mitigating climate change through agroforestry: exploring perceived efficacy, cues and practices in a community of Nigerian farmers

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Abstract. This study investigates the perceived efficacy of agroforestry as a climate change mitigation strategy and other motivating factors influencing farmers' adoption of agroforestry practices, specifically in Oyo State, southwestern Nigeria. A survey involving 400 respondents utilized structured questionnaires to gather data. Statistical analyses, including independent samples t-test and one-way ANOVA, were employed to assess differences in agroforestry practices based on gender and age/education sub-groups. The relationship between perceived efficacy, cues to agroforestry, and agroforestry practices was examined using the Pearson correlation coefficient. Findings indicate that while 83.0% of respondents had previously engaged in agroforestry, current engagement reduced sharply to 42.8%. Gender significantly influenced agroforestry practices, with women at a disadvantage ($p < 0.05$), whereas age and education did not show significant effects ($p > 0.05$). Perceived efficacy showed an insignificant relationship with agroforestry practices ($r = 0.069$, $p > 0.05$), contrasting with cues to agroforestry which exhibited a significant positive correlation ($r = 0.379$, $p < 0.05$). Despite the substantial perceived efficacy of agroforestry in mitigating climate change, this perception does not translate into actual agroforestry practices among farmers. The study underscores the importance of introducing cues and prompts to bridge the gap between ideal perceptions and behaviour/adoption, thereby enhancing the efficacy of agroforestry as a climate change mitigation strategy, particularly in developing contexts like Nigeria.
Key words: Agroforestry, climate change, perceived efficacy, cues to action, farmers.

Introduction

Climate change represents a huge limitation to human interests globally. This change reworks seasons, causes droughts, floods, increases sea levels, and threatens wildlife. These and more adverse consequences create huge challenges in virtually all fields of human endeavour, especially agriculture (Barkdull & Harris, 2019). Climate change is a direct cause of the Nigerian farmer-herders crisis (Nnoko-Mewanu, 2018). The eco-violence theory of human conflicts supposes that the dwindling environmental resources like water, forest products and land, which is worsened by climate change, create human conflicts (Homer-Dixon, 1999). Worse still, the challenge of climate change appears to be escalating rather than otherwise. Climate change is substantiated by the incidence and intensity of extreme weather episodes, such that there has been an upsurge in the incidence of warm days and nights but a decline in the incidence of chilly days and nights (Pathak *et al*., 2018). Globally, the highest temperatures are recorded in the current century. A comparison of average global temperature from 1850 to 1900 and from 1998 to 2018 indicates there has been an increase of 1.41ºC (IPCC, 2019).

Climate change is consequent upon the huge use of fossil fuels, the pervasiveness of deforestation which is driven by the expanded need for food owing to the increasing population as well as industrialization (IPCC, 2019). These and many more factors resulted in high levels of greenhouse gas emissions.

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Unfortunately, climate change has a considerably negative bearing on agriculture. For instance, every increase in global temperature reduces the yield of wheat by 4 to 6% (Liu *et al*., 2016). Similarly, the yield of maize has been projected to wane in 56% of the maize-producing areas globally (Zhao *et al*., 2017). This makes it necessary for agricultural systems to adjust accordingly, including in the alteration of land practices (Anderson, Bayer & Edwards, 2020). Agriculture often involves the conversion of the forest ecosystem in the interest of food production (Firbank, 2019). It is the biggest driver of biodiversity loss in current history (Firbank, 2019; FAO & UNEP, 2020). Yet, the forest ecosystem is extremely essential in the functionality of the entire ecosystem. Indeed, forests preserve and restore soil fertility, alter the destructive capacity of winds, control erosion, serve as a haven for pollinators and perform numerous other functions that contribute generously to sustainable agriculture. Hence, an integrated landscape approach such as agroforestry, which allows for the synergetic combination of forestry and agriculture, remains germane to environmental sustainability.

Agroforestry is a robust and win-win solution to numerous environmental challenges of our time. It involves the combination of the planting and management of trees, crops as well as livestock. It is an ecosystem-based adaptation, which has emerged as a prominent route to coping with climate change (Barkdull & Harris, 2019). Agroforestry is a traditional production system that is widely practised across climatic zones in Africa south of the Saharan (Rosenstock *et al*., 2019). Owing to the deep alteration of environmental dynamics because of various forms of human activities, the prospect of a nature-based solution that agroforestry represents cannot be over-emphasized. Agroforestry is especially relevant in sub-Saharan Africa because the region is most liable to experiencing the negative outcomes of climate change (Esham & Garforth, 2013). The limitedness of socio-economic development of this region limits the potential for adopting high-tech climate change adaptation solutions (Bagamba *et al*., 2012). Agroforestry offers a unique means for low resource farmers and their communities to safeguard their livelihood while also protecting their environment (Di Falco & Veronesi, 2013s).

Governmental policy is largely on the side of instituting agroforestry as a land-use option in Africa. About 70% of African governments have committed themselves to adopting agroforestry as a climate change mitigation strategy (Rosenstock *et al*., 2019). Still, practising agroforestry optimally is a socio-psychological decision. This practice thrives with improved perception of its efficacy in solving agriculture-related issues, such as the challenge of climate change. The active promotion of agroforestry not just by policymakers but also by multiple stakeholders including extension agents and non-governmental organizations (NGOs) is very crucial (Barkdull & Harris, 2019; Atube *et al*., 2021). The degree to which state and non-state actors prioritize and promote agroforestry will direct the availability of cues, which will prompt engagement in agroforestry practices. Firbank (2019) asserted that “expertise in public engagement” is crucial in instituting effective conservation practices. In this light, the empirical analyses of farmers’ perception of the efficacy of agroforestry as a remedy for climate change, their reported cues to agroforestry and the extent of their engagement in agroforestry are germane to understanding the dynamics of socio-psychological dynamics of agroforestry especially in developing contexts. Such dynamics will acknowledge the state of affairs and showcase the impetus for promoting the optimal practice of agroforestry. Hence, the objective of this study was to examine the perceived efficacy of agroforestry as a remedy for climate change as well as cues to agroforestry and to determine how these influence respondents’ engagement in agroforestry. The study also aimed at determining the influence of gender, age and education on the respondents’ engagement in agroforestry and also identified the forms of agroforestry practised and the types of tree species planted by respondents. The research questions are as follows:

1. How do respondents perceive the efficacy of agroforestry as a remedy for climate change?
2. What are the cues to agroforestry among respondents?
3. How do perceived efficacy and cues to agroforestry influence respondents’ engagement in agroforestry?
4. What is the influence of gender, age and education on the respondent’s engagement in agroforestry?
5. What are the forms of agroforestry practised and the types of tree species planted by respondents?

Materials and Methods

Study areas

The study areas were the Oyo East and the Oyo West Local Government Areas (LGAs), Oyo State, Nigeria. Nigeria is a vast sub-Saharan, West-African country. It has a total land coverage of 923,773 km^2. It is the most populous Black Country in the world and has the largest population in Africa. Projection shows that Nigeria’s current population of over 200 million will surpass 300 million by 2050 (Ogbonnaya

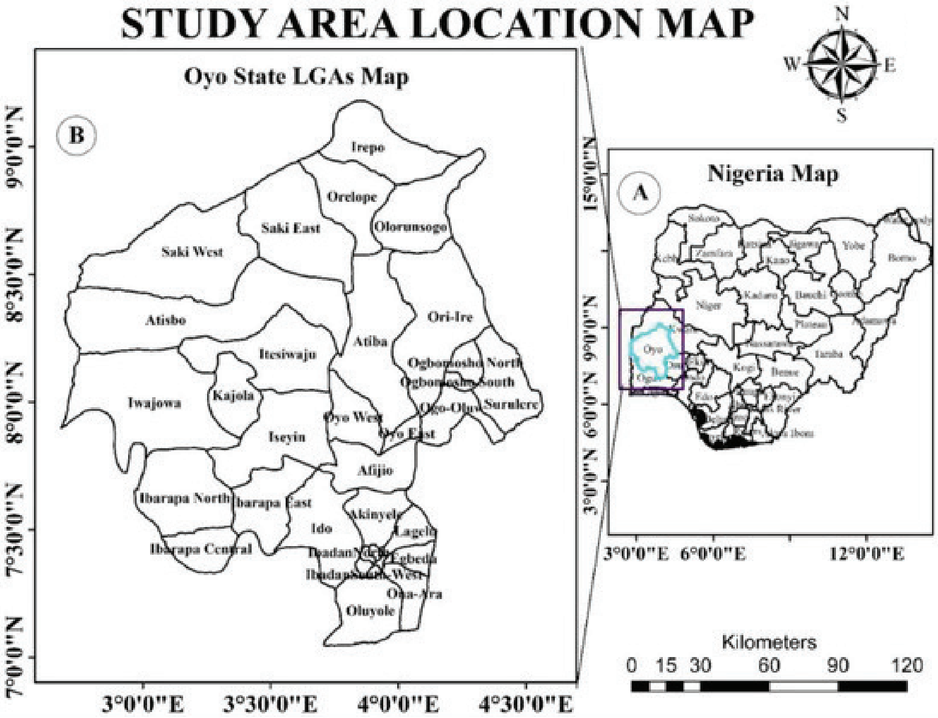

Figure 1. A map of the study area.

et al., 2019). Nigeria has one of the largest economies in Africa. It is endowed with a huge base of natural resources and occupies a central position in African leadership (Akanle & Shittu, 2022). Nigeria is divided into six geo-political zones, of which the southwestern region is one of the same. This region is the native land of the Yorùbá people and Oyo state happens to be one of the six states that constitute the southwestern region. Oyo state is divided into 33 geo-political units known as Local Government Areas (LGAs). Ibadan, the capital of Oyo state, encompasses five metropolitan and six peri-urban LGAs. The remaining twenty-two LGAs are generally rural, though many areas can be considered as semi-urban in outlook. Oyo East and Oyo West are part of these twenty-two LGAs. Along with Atiba LGA, these two LGAs also constitute Oyo town, a popular and historically significant Yorùbá community. Oyo town was the seat of a dominant polity in pre-colonial Yorùbá land (Oludare & Sogbesan, 2021). The total land area of Oyo East and Oyo West LGA is 144km^2 and 526km^2 respectively. The LGAs are located at 7°52’43.61” N 4°01’16.75”E and 7°56’29.65” N 3°49’18.48”E respectively. They are headquartered at Kosobo and Ojongbodu, respectively, and they are both located north of Ibadan. Oyo East and Oyo West are made up of 9 and 10 political wards, respectively. The latest of Nigeria’s censuses indicates that the population of Oyo East and Oyo West LGAs are 123,846 and 136,236, respectively (National Population Commission, 2007). The people are typically farmers who plant vegetables and food crops including yams, cassava and maize.

Study design

The study was a cross-sectional survey, which means it was non-experimental and targeted crop farmers in selected communities. It was conducted at a single point in time, involving randomly selected groups of crop farmers.

Sampling procedure

The sampling of respondents was clustered, random and multi-staged. In the first stage, the study population was projected. Oyo East and Oyo West populations were evaluated (123,846 + 136,236 = 260,082). The 2021 projected population at a 2.6% growth rate was estimated by employing the formula below:

$$P = P_0 \times e^{rt}, \qquad \text{Equation (1)}$$

where:

P - final population;
Po - initial population;
e - exponential;
r - growth rate;
t - time interval (15 years).

The projected population was therefore 384,136 (total population [N]). This N is robust because not everyone is engaged in farming. However, farming is the dominant occupation in the study area including most other non-urban areas of Nigeria. Occupation-specific population information in the study area is seemingly non-existent.

The second stage of the sampling procedure was the determination of sample size. Equation 2 was used to determine the sample size (n):

$$n = \frac{Npqz^2}{e^2(N-1)+pqz^2}, \qquad \text{Equation (2)}$$

where:

p - the assumed ratio of the population who showcase the sentiment/behaviour of concern, 50%= 0.5;
q - 1–p;
z - 1.96 (95% confidence from z table);
e - the precision level = 5% or 0.05;
n - 384. This figure was enlarged to 400.

The third stage of the sampling process was the random selection of four wards in each LGA. In Oyo East, Ajagba, Apaara, Alaodi/Modeke and Oke Apo wards were selected. In Oyo West, Ajokidero, Fasola/Soku, Iseke and Isokun were selected. The fourth stage was the identification of villages and communities in each of the eight randomly selected wards. The fifth stage was the random selection of two communities from each ward. Hence, in Oyo East, Imeleke, Ogbagba, Obede, Onsa, Ago-ana, Gudugbu-orile, Abu and Jakan were selected. In Oyo West, Oloya, Ogunda, Fasola, Soku, Apogidan, Ejemu, Obanoko and Orowole were selected. The study took place in sixteen randomly selected villages/communities. The sixth stage was the random selection of respondents. This was accomplished by enlisting the assistance of farmer associations in each community. The list of members was designated as sampling frames and systematic random sampling doctrine was used to calculate the sampling intervals (k), which enabled the random selection of specific respondents. Where the selected prospective respondent was unavailable or unwilling to participate, another willing but unselected respondent replaced him or her. Twenty-five replicas of the study instrument were administered in each of the sixteen communities.

Questionnaire

The questionnaire was made up of an 8-item author-constructed scale that was used to measure the perceived efficacy of agroforestry as a remedy for climate change. This variable was defined as the respondent's belief about the capability of agroforestry to produce outcomes that are useful for coping with and controlling climate change. The response categories for the items in the scale included 'absolutely true' (2), 'fairly true' (1) and 'not true at all' (0), making the possible total score range from 0 to 16. The scale was reliable (Cronbach alpha = 0.695). Sample items include 'the planting of trees along with crops is a good way to deal with climate change', and 'the planting of trees along with crops can reduce the amount of greenhouse gases which causes climate change'.

The questionnaire also consisted of an 8-item index that was used to assess cues to agroforestry. Cues to agroforestry was operationally defined as prompts available to or experienced by farmers, which motivates agroforestry practices. Responses categories were yes (1) and no (0), making the possible total score range from 0 to 8. An example of items in the index is: 'Have you ever been encouraged to plant trees along with crops through media message(s)?'. Agroforestry practice was defined as the respondent's engagement in the farming of trees and crops concurrently. It was examined using a 4-item index, responses were yes (1) and no (0). Hence, the possible total respondent's score could range from 0 to 4. An example of items in the index is: 'In the current planting season, did you plant trees along with crops?' Other items of the author-constructed scale and indexes are contained in Table 2, Figures 2 and 3. The study questionnaire also consisted of a 5-item index which was used to assess types of agroforestry practised by respondents (intercropping, windbreak, riparian/streambank, woodlot/plantation and silvipasture) while another open-ended index was used to examine the types of tree species planted by respondents.

The questionnaire was converted into Yorùbá, the language of the community. This is to be able to communicate optimally with some respondents who may not be conversant with the English language. Copies of the questionnaire were administered to respondents via structured interviews. This facilitated the achievement of the highest response rate (100%). Data collection took place in August/September 2021. Respondents' autonomy was respected, with a deep regard for their right to self-determination. They were approached with utmost respect, and their participation in the study was sought only after presenting them with essential information about the research in a language they understood. Consent was obtained through the signing or thumbprint marking on the informed consent form, serving as formal documentation of their agreement.

Hypotheses

H_o1: Perceived efficacy and cues to agroforestry have no influence on respondents' engagement in agroforestry.

H_o2: Gender, age and education have no effects on the respondent's engagement in agroforestry.

Data analysis

The socio-demographic profiles of respondents were examined using frequencies and percentages.

Means and standard deviations were used to examine the summary of items in the scale of perceived efficacy of agroforestry as a remedy for climate change. Stacked bar charts were used to highlight the distributions of items in the indexes used to assess cues to agroforestry, agroforestry practices, types of agroforestry practised and the types of tree species planted. Kolmogorov-Smirnov test was employed to assess the normalcy of distributions of perceived efficacy, cues to agroforestry and agroforestry practices. These distributions were normal ($p > 0.05$). The significance of the difference in respondents' agroforestry practices across sub-groups of gender and age/education were tested using independent samples *t*-test and one-way ANOVA respectively. Levene's test was employed to determine the homogeneity of variance across sub-groups of gender, age and education. Eta and eta^2 were used to examine effect size. Pearson correlation coefficient was used to examine the relationship between pairs of perceived efficacy, cues to agroforestry and agroforestry practices. SPSS version 24 was used for data analysis.

Results and Discussion

Socio-demographic characteristics of respondents

The majority of respondents were men (77%) but women were a noticeable proportion of respondents (23%). The age of most respondents (34.5%) was from 36 to 45 years. The proportions of respondents aged from 26 to 35 (20.3%) and 46 to 55 (21.8%) were close. The distribution of age of respondents appears normal and was highest at the 36-45 age sub-group. This suggests that middle-aged people in the study area dominate farming. Meanwhile, the age distribution of respondents is still very divergent: the mean ±SD of age was 43.13±12.95, the youngest and oldest respondents were 16 and 80 years old respectively. Respondents who had— no formal education, primary and secondary education constituted the greatest proportion (33.8%), a greater proportion (27.0%) and a great proportion (23.8%) of respondents respectively. Meanwhile, respondents who had post-secondary education were merely close to a tenth (8.5%) while first degree and postgraduate degree holders were 4% and 3% respectively. The socio-demographic characteristics of respondents is presented in Table 1.

Analyses of items of the perceived efficacy scale

The analyses of items in the scale of perceived efficacy in Table 2 indicate that respondents' agreement with items was generally high. Item means ranged from 1.52 to 1.98 (minimum = 0, maximum = 2). The generic item which affirmed that agroforestry 'is a good way to deal with climate change' attracted the greatest agreement among participants (mean = 1.98). This is a clear indication that people strongly link agroforestry with tackling climate change in the study area. The items which asserted that agroforestry could 'reduce air pollution and 'enhance the cooling of the atmosphere' also attracted great agreement

Table 1

Socio-demographic profile of respondents (N =400)

Socio-demographic characteristic	Sub-groups	Frequency	Percentage
Gender	Male	308	77.0
	Female	92	23.0
Age*	16-25	34	8.5
	26-35	81	20.3
	36-45	138	34.5
	46-55	87	21.8
	56-65	41	10.3
	66-above	19	4.8
Education	Non-formal	135	33.8
	Primary	108	27.0
	Secondary	95	23.8
	Post-secondary	34	8.5
	First degree	16	4.0
	Postgraduate	12	3.0

**The mean ±SD of age was 43.13±12.95 (lowest = 16, highest= 80).*

(mean = 1.95). Reduction in the amount of greenhouse gases that cause climate change (mean = 1.83), combating flooding (mean = 1.83) and preventing soil erosion are issues that respondents quite agreed with. The usefulness of agroforestry in combating drought attracted the least agreement (mean = 1.44) while respondents' agreement with the idea that agroforestry 'creates a resilient microclimate for crop productivity' was also quite weak (mean = 1.52). Other studies have shown a similar pattern of responses: a study in Bohol, Philippines (Lasco, Espaldon & Habito, 2015) revealed that 54.3% of respondents who had trees on their farms believed that trees help to manage the negative consequences of climate change and they maintained the trees even when they benefit zero income therefrom. Owombo, Idumah & Adepoju (2018) reported that in Edo State southern Nigeria, 80.3% of respondents demonstrated the understanding

Table 2

Item analysis of the perceived efficacy scale

Perceived efficacy of agroforestry as a remedy for climate change	Mean ± SD	Minimum	Maximum	Cronbach's alpha
The planting of trees along with crops is a good way to deal with climate change	1.98±0.148	1	2	0.695
The planting of trees along with crops can prevent soil erosion	1.74±0.438	1	2	
The planting of trees along with crops can reduce air pollution	1.95±0.245	0	2	
The planting of trees along with crops can enhance the cooling of the atmosphere	1.95±0.218	1	2	
The planting of trees along with crops can reduce the amount of greenhouse gases that causes climate change	1.83±0.380	1	2	
The planting of trees along with crops can combat drought	1.44±0.527	0	2	
The planting of trees along with crops is a good way to combat flooding	1.83±0.404	0	2	
The planting of trees along with crops can create a resilient microclimate for crop productivity	1.52±0.500	1	2	

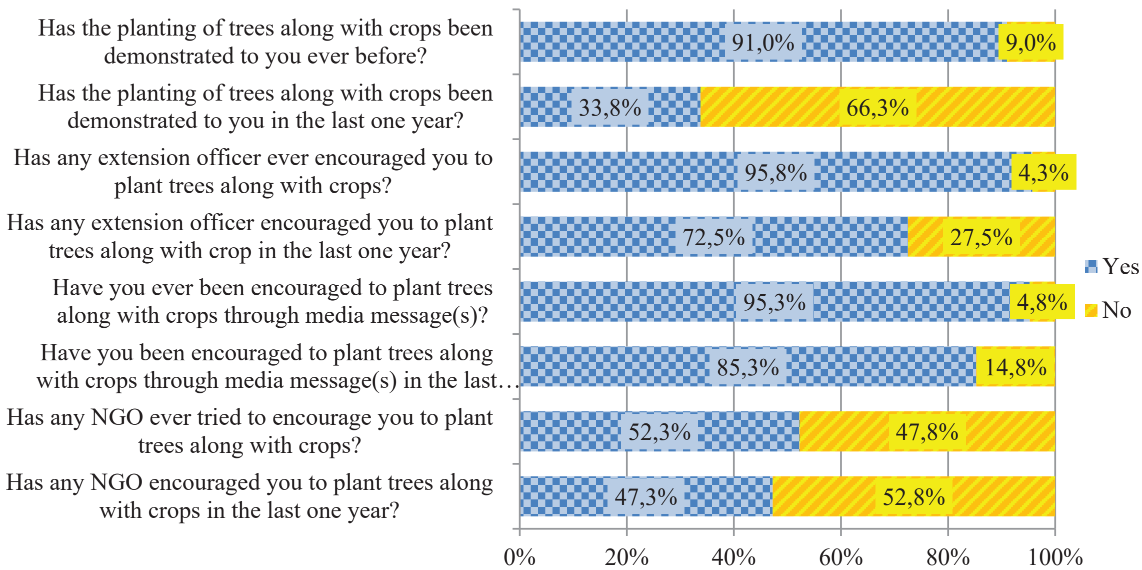

Figure 2. Element of cues to agroforestry.

that agroforestry helps in climate change mitigation. These generally imply a good measure of farmers' understanding of the perceived efficacy of agroforestry in checking climate change.

Cues to agroforestry

Figure 2 indicates that a huge proportion of respondents have ever been encouraged to engage in agroforestry by an extension agent (95.8%) and through media message (95.3%). There were small reductions in these proportions to 72.5% and 85.3% respectively when the one year before the survey alone is considered. Figure 2 also shows that 91% of respondents have ever learned about agroforestry through demonstration but this percentage reduced drastically to 33.8 when the last one year before the survey alone is considered. In sharp contrast to the proportions earlier reported, 52.3% of respondents have ever been encouraged to engage in agroforestry by non-governmental organizations (NGOs) and this proportion reduced to 47.3% when the one year before the survey alone is focused on. Elements of cues to agroforestry are prevalent but declines in more recent times.

Agroforestry practices among respondents

Figure 3 shows that 83.0% of respondents had ever engaged in agroforestry while another overwhelming majority (90.2%) consider themselves to be good practitioners of agroforestry. The majority of respondents (81.8%) also affirmed that agroforestry is an important part of their farming operations. However, the proportion of respondents who were affirmative about their current engagement in agroforestry reduced sharply to 42.8%. Hence, historical antecedents strongly suggest the huge popularity of agroforestry but the current agenda reveals the fair commitment to agroforestry among the farmers. Respondents' current agroforestry practices indicate that about 4 in every 10 farmers in the study area actively pursue agroforestry. Conteh *et al*. (2016) also found that 46.3% of their respondents embraced agroforestry. Mekonnen (2009) also used panel data to examine tree planting in the Amhara region, Ethiopia and reported that tree planting decreased from 52% to 42% and then to 33% in the years 2000, 2002 and 2005 respectively. Meanwhile, the current finding is a lot better than the rate of adoption reported by Oduniyi & Tekana (2019). Oduniyi & Tekana (2019) reported that only 9.4% of their respondents in the North West province of South Africa adopted agroforestry. Similarly, Jha, Kaechele & Sieber (2021) reported that only 10.19% of their respondents in selected central and coastal areas of Tanzania actively engaged in agroforestry i.e. planted a tree in the year before their study. Nevertheless, much higher rates of agroforestry were reported elsewhere: Meijer *et al*. (2015) found that 76% of their respondents in Malawi planted trees on their farms within the last five years before their study. Cyamweshi *et al*. (2021) also reported that 81.5% of their respondents in north-western Rwanda practised agroforestry. The current extent of tree planting vindicates the position of Partey *et al*. (2017) who reckoned that the adoption of agroforestry is relatively low, in the report of their review of studies concerning agroforestry and sustainable development in sub-Saharan Africa. The promotion of agroforestry in the study area is called for, considering the huge environmental and socioeconomic benefits accruable from the same (FAO & UNEP, 2020).

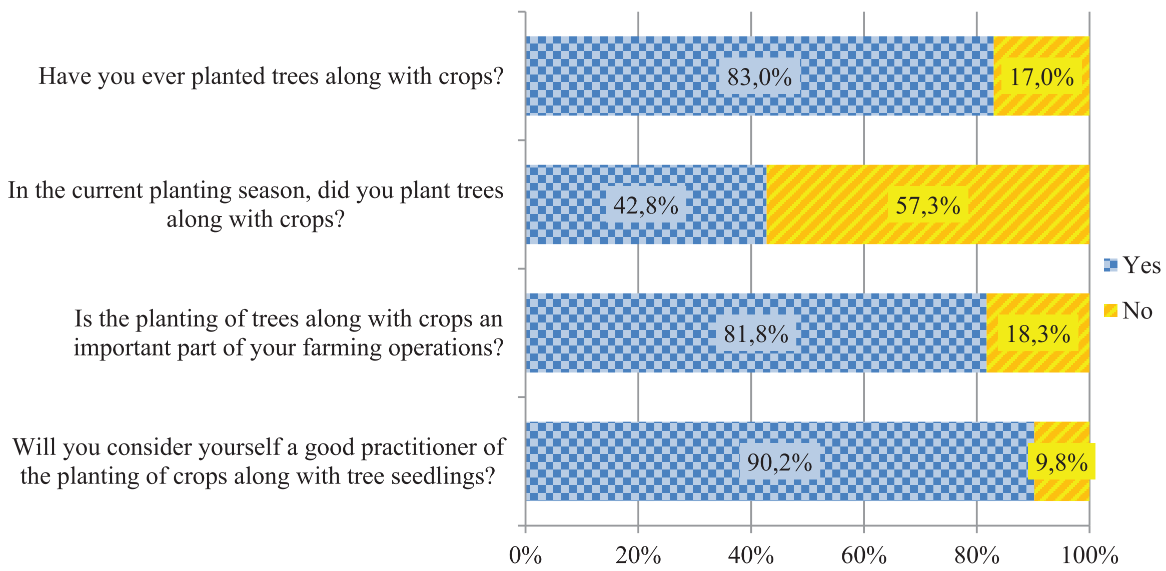

Figure 3. Elements of agroforestry practices.

The influence of socio-demographic characteristics on respondent's engagement in agroforestry practices

The outcome of bivariate analyses (Table 3) shows that male respondents engaged in agroforestry practices more (mean = 3.02) when compared with their female counterparts (mean = 2.50). The difference in means between the genders are significantly different ($p < 0.05$). The results of Levene's test did not indicate homogeneity of variance between sub-groups of gender ($p < 0.05$), results indicate significant differences even when homogeneity of variance of these sub-groups are not assumed ($p < 0.05$). Hence, gender has a main effect on engagement in agroforestry practices and this is in disfavour of women. Similarly, Conteh *et al*. (2016) reported that gender is a significant factor in agroforestry adoption among a group of farmers in Sierra Leone, but this was in favour of women. More women frequently adopted agroforestry when compared with their male counterparts. However, Meijer *et al*. (2015) reported that the sex of the household head did not significantly affect tree planting or the density of trees planted among a group of farmers in Malawi. Abiyu *et al*. (2015) similarly reported no significant difference in the number of trees planted between male and female-headed households in northwest Ethiopia. Current findings confirm the unfavourable status of women's efforts in agroforestry matters. Eta is 0.157 while eta^2 is 0.025. Therefore, the extent to which gender explains the variance in agroforestry practices is 2.5%.

The bivariate analyses of age and agroforestry practices did not reflect the influence of increased or decreased age on the extent to which agroforestry was practised by respondents. For instance, the 56-65 and the 46-55 sub-groups exhibited the best (mean = 3.29) and the better (mean = 3.18) extent of agroforestry practices respectively. The 36-45 sub-group ranked third (mean = 2.72) of the six age sub-groups while the 66-above ranked fourth (mean = 2.58). Although the result of ANOVA shows that means among sub-groups of age were significantly different ($p < 0.05$), the results of Levene's test limits the validity of this significant difference because it did not suggest sub-group homogeneity of variance ($p < 0.05$). Hence, it is difficult to conclude that age has a main effect on the extent to which agroforestry is practised among respondents. Amare & Darr (2020) conducted a meta-analysis of studies that examined the adoption of agroforestry and reported that among the 86 studies in which the influence of age was assessed, 12, 17 and 57 studies reported a negative, positive, and unrelated influence of age on agroforestry adoption.

Table 3

Effects of gender, age and education on agroforestry practices

Socio-demogra-phic variable	**Sub-groups**	**Mean±SD**	**Levene's test for homogeneity of variances**		**Independent samples *t*-test**		**ANOVA**		**Eta**	**Eta^2**
			Levene's statistic	***p* value**	***t* statistic**	***p* value**	**F statistic**	***p* value**		
Gender	Male	3.02±1.33	14.385	0.000	3.172	0.002	-	-	0.157	0.025
	Female	2.50±1.57			2.905	0.004*				
Age	16-25	2.35±1.81	7.779	0.000	-	-	3.210	0.007	-	-
	26-35	3.01±1.29								
	36-45	2.72±1.51								
	46-55	3.18±1.16								
	56-65	3.29±1.06								
	66- above	2.58±1.50								
Education	Non-formal	2.87±1.38	1.894	0.094	-	-	0.949	0.449	-	-
	Primary	2.71±1.53								
	Secondary	3.03±1.34								
	Post-secondary	3.00±1.48								
	First degree	3.25±1.00								
	Postgraduate	3.25±1.14								

** Equal variances not assumed*

Table 4

Relationship between pairs of perceived efficacy, cues to agroforestry and agroforestry practices

		Perceived efficacy	Cues to agroforestry	Agroforestry practices
Perceived efficacy	*R*	1	.068	.069
	p value		.175	0.167
Cues to agroforestry	*R*	.068	1	.379*
	p value	.175		.000
Agroforestry practices	*R*	.069	.379*	1
	p value	0.167	.000	

**Significant correlation*

Similarly, Conteh *et al*. (2016) report that there was no significant influence of age on the adoption of agroforestry. This embosses the idea that age is hardly relevant in agroforestry adoption matters.

Except for a minor limitation, agroforestry practices generally increased with increasing education: means were 2.87 and 2.71 among respondents who did not have formal education and those who had primary education respectively. Means were also 3.03 and 3.00 among those who had secondary education and post-secondary education respectively. Finally, mean agroforestry practice remained constant at 3.25 for first-degree and postgraduate degree holders. These descriptive data suggest the increasing extent of agroforestry practice, as respondents' level of education increases. However, there is no significant effect of education on agroforestry practice ($p > 0.05$) and sub-group variance was homogenous across sub-groups of education ($p > 0.05$). Similarly, Conteh *et al*. (2016) found that education was an insignificant factor in the adoption of agroforestry among a group of farmers in Sierra Leone. The influence of increasing education on the extent to which agroforestry is practised is noticeable but this is insignificant. This suggests the trivial role of education in agroforestry practices in the study area.

Influence of perceived efficacy and cues on agroforestry practices

The correlation coefficients in Table 4 indicate that there is a positive, weak and insignificant relationship between perceived efficacy and agroforestry practices ($r = 0.069$, $p > 0.05$). This implies that the perception of agroforestry as a remedy for climate change is inconsequential in the extent of people's engagement in agroforestry. On the contrary, the significant relevance of perceived efficacy was suggested elsewhere: Lasco, Espaldon & Habito (2015) reported that the planting of trees was significantly related to farmers' perception of the role of trees in coping with the negative effects of climate change in Bohol, Philippines. The perceived effect of agroforestry on drought was significantly determinant of agroforestry adoption in Edo state, southern Nigeria (Owombo, Idumah & Adepoju, 2018). Perhaps, the peculiarities of the study context are at play, making this finding an interesting focus for further studies. Current findings uphold the notion that people' belief about the capability of agroforestry to produce outcomes that are useful for coping with and controlling climate change does not necessarily translate to improved practice of agroforestry.

However, there is a positive, fairly strong and significant relationship between cues to agroforestry and agroforestry practices ($r = 0.379$, $p < 0.05$). Hence, the higher the cues, the higher the practice of agroforestry. Previous studies are generously in support of this finding: Conteh *et al*. (2016) reported that demonstration enhanced the practice of agroforestry in western Sierra Leone. In their study among farmers of four rural communities of Freetown Peninsula of Sierra Leone, Conteh *et al*. (2016) reported that NGOs and extension agents were named as the source of information by 47% and 26.9% of respondents who practised agroforestry respectively. Access to extension agents was significant in agroforestry adoption (Conteh *et al*., 2016). Gyau *et al*. (2012) as well as Owombo & Idumah (2017) similarly reported that extension services facilitated the adoption of agroforestry in northwestern Cameroun and southwestern Nigeria respectively. The current findings and extant literature uphold the position that cues to action are of huge importance in people's uptake of agroforestry. Cues to agroforestry in the form of prompts available to, or experienced by farmers are germane to the optimal practice of agroforestry.

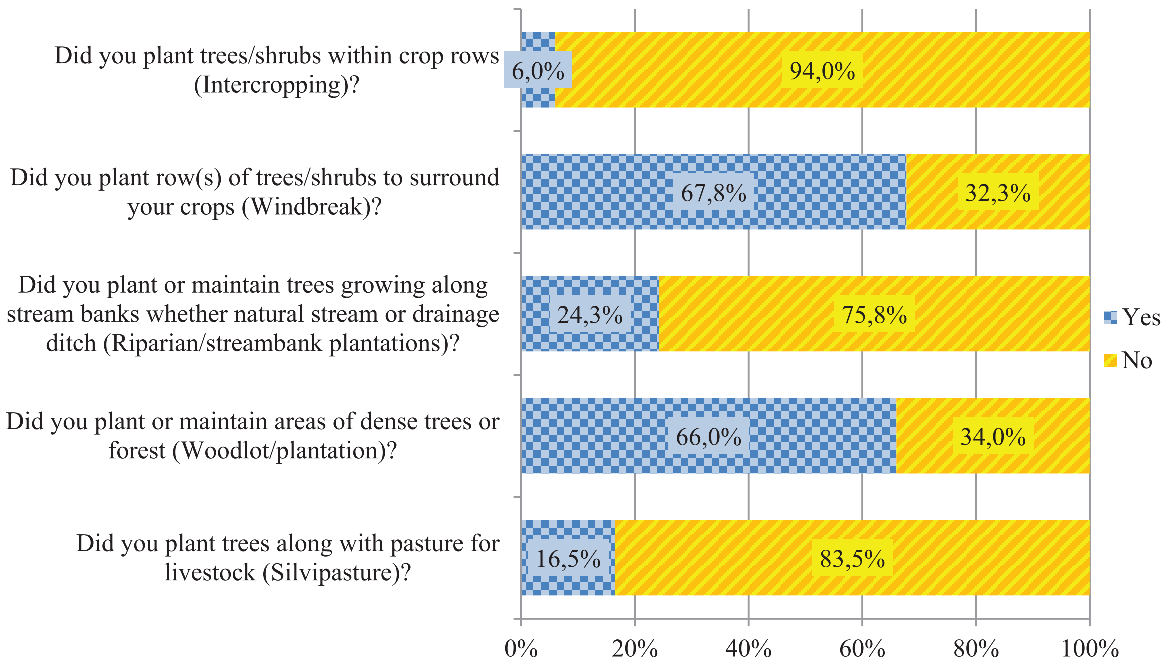

Figure 4. Types of agroforestry practized by respondents.

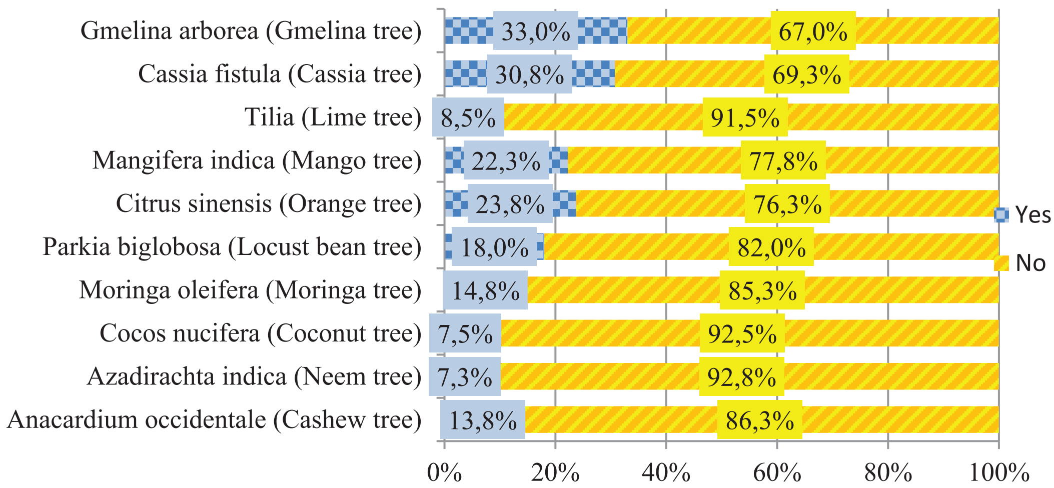

Figure 5. Distribution of types of trees planted.

Types of agroforestry practised among respondents

The data presented in Figure 4 indicate that windbreak (67.8%) and woodlot/plantation (66.0%) were the most common forms of agroforestry that were practised in the study area. Riparian was practised by up to a quarter of respondents (24.3%), silivipasture was practised by 16.5% of respondents while intercropping was the least popular form of agroforestry (6.0%). Extant findings are rather divergent from the current. Whereas woodlot was practised in the current study by 66.0% of respondents, it was only 1.4% in north-western Rwanda (Cyamweshi *et al*., 2021) and 19.4% in northern Ethiopia (Manaye *et al*., 2021). Windbreak was practised by 67.8% in the current study but 45% (Cyamweshi *et al*., 2021) and 7.1% (Manaye *et al*., 2021) elsewhere. Intercropping was 32.4% (Cyamweshi *et al*., 2021) as opposed to the current proportion of 6.0%. These reflect the peculiarities of different socio-ecological contexts including resources and preferences of divergent peoples.

Trees planted by respondents

The information highlighted in Figure 5 indicates that respondents planted ten tree species: *Gmelina Arborea* (gmelina tree, 33.0%) and *Cassia fistula* (cassia tree, 30.8%) were the most popular tree species planted. *Citrus sinensis* (orange tree, 23.8%)

and *Mangifera indica* (mango tree, 22.3%) were also popular species of trees planted. *Parkia biglobosa* (locust bean tree, 18.0%), *Moringa oleifera* (moringa tree, 14.8%) and *Anacardium occidentale* (cashew tree, 13.8%) were also quite popular. *Azadirachta indica* (neem tree, 7.3%), *Cocos nucifera* (coconut tree, 7.5%) and *Tilia* (lime tree, 8.5%) were the least popular tree-species planted. The total number of species planted by respondents is comparable to the number reported by Jha, Kaechele & Sieber (2021), who found that eight species were planted in Tanzania. However, current findings are much lower than previously reported among different farmer-sub-populations: 25 species in northwest Ethiopia (Abiyu *et al*., 2015); 27 species in central highlands of Ethiopia (Duguma & Hager, 2010); 59 species in northern Ethiopia (Manaye *et al*., 2021). Species diversity is germane to the success of agroforestry (Tschora & Cherubini, 2020). Hence, in addition to optimizing agroforestry, greater use of varieties of tree species deserves promotion in the study area.

Conclusions

Farmers in the study area exhibit a commendable understanding of the vital role agroforestry plays in mitigating climate change. However, while cues to agroforestry are perceptible, they have not yet reached their full potential in the study area. Despite historical precedents highlighting the prevalence of agroforestry, current practices indicate that its adoption remains below optimal levels within the target population. Interestingly, gender emerges as a noteworthy factor in agroforestry practices, with men's involvement holding significance. Nevertheless, factors such as age and education do not exert a substantial influence. Enhancing women's contributions to agroforestry systems stands out as an area for improvement within the target population. Moreover, it's noteworthy that while farmers express confidence in the effectiveness of agroforestry as a climate change mitigation strategy, this belief does not necessarily translate into enhanced agroforestry practices. Nonetheless, the presence of cues and prompts related to agroforestry plays a significant role in influencing people's engagement in agroforestry. In light of these findings, there is a clear imperative to optimize agroforestry practices in the study area, particularly focusing on enhancing women's participation. This optimization could greatly contribute to harnessing the full potential of agroforestry as a sustainable solution to climate change challenges.

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