EVALUATION OF CULTURAL ECOSYSTEM SERVICES OF PULPWOOD MULTIFUNCTIONAL AGROFORESTRY: A CASE STUDY FROM THE FOOTHILLS OF THE NILGIRIS, WESTERN GHATS, INDIA

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Abstract. The significance of the cultural ecosystem services of the different agro landscapes is increasingly recognized as a non-material benefit linking humans and nature. However, studies on the valuation of cultural ecosystem services of agroforestry landscapes are meagre. Hence the present study was conducted at Forest College and Research Institute, Mettupalayam, Tamil Nadu, India to evaluate the cultural ecosystem services (CES) of Pulpwood Multifunctional Agroforestry (PMFA), which consists of 8 pulpwood tree species and 4 perennial intercrops. Various workshops and capacity-building programs were conducted and a total of 112 participants were part of the study and they were given a questionnaire regarding their experience, perception and understanding of the cultural ecosystem services of PMFA. Most of the respondents preferred to spend some quality time in the field followed by acquiring scientific knowledge. With respect to the perception of socio-cultural characteristics of individuals towards CES, it was observed that income and education level have a positive impact on CES. The average Willingness to pay (WTP) was Rs. 48/visit and principal component analysis showed only one component, which means one component is enough to explain the variance of the data. The results of the study revealed that the model provides scope for ecotourism which will provide additional income to small landholders
Keywords: *biodiversity, intangible benefits, willingness to pay, cultural services, payment for ecosystem service*

Introduction

The shifting trends toward counting intangible services have provided more value to the ecosphere. The unseen benefits that are rendered by the ecosystem of the earth were dug into in recent eco-research studies and priced in terms of monetary value (MA, 2003). An important milestone in the advancement of ecosystem research and study was the Millennium Ecosystem Assessment conducted by the United Nations in 2005 (MA, 2005), which categorized ecosystem services into 4 broader groups viz., provisional, regulating, supportive and cultural services. Cultural ecosystem services are intangible or non-material or non-monetary benefits like aesthetic, recreation, relaxation, education, knowledge, spiritual well-being, pleasure, biodiversity, etc. benefits we get from the environment (Cheng et al., 2019; Schaich et al., 2010; Zhang et al., 2007). Valuing ecosystem services for both tangible and intangible benefits to human society is one of the keys to achieve sustainable goals like poverty alleviation (SDG 1), hunger reduction (SDG 2), climate change action (SDG 13), and biodiversity conservation and sustainable land management (SDG 15) of the United Nations (Kuenkel, 2019). All the ecosystems from small to large, provide services at different levels which vary with different land use systems.

The practice of agroforestry (cultivating agricultural crops with trees) is an age-old practice that has been followed for a long time in many parts of the world (Nair et al., 2021). Agroforestry is defined as a sustainable land use system in which trees and crops are grown on the same unit of land (Noordwijk, 2019). It is one of the alternative land-use systems to agriculture and contributes immensely in meeting four out of 17 Sustainable Development Goals. The features of the landscape that contribute to the ecosystem services are found more important in agroforestry than in agricultural landscapes (Zanten et al., 2016). Due to the vagaries of the monsoon, climate change risk, decrease in soil fertility, and land degradation, agroforestry gained momentum for sustainable development (Moreno et al., 2018). Agroforestry is practiced by 1.2 billion people worldwide, who occupy 10% of all agricultural lands. In India, Agroforestry is a traditional land use system and it is estimated that the area under agroforestry is 8.65% (28.43 m ha) of the total geographical area of the country (Arunachalam et al., 2022).

Agroforestry, besides improving livelihood, also contributes several ecosystem services viz., provisional, regulating, supporting, and cultural benefits (Barrios, 2018). Agroforestry systems consist of region-specific diverse landscape models along with localized traditional systems. However, newly developed unique models like Multifunctional Pulpwood Agroforestry Model (PMFA) has gained more importance due to their multifaceted services. The concept of PMFA recognizes the diversification of tree and crop components in the same unit of land with multi-output products delivering not only commodity benefits but also non-commodity services. PMFA is emerging as a new innovative concept particularly suitable for small landholders due to its multi-functionality in improving the livelihood of small farmers, along with providing aesthetic, recreation, personal well-being, knowledge, education, spiritual enrichment, biodiversity conservation, and understanding of the complexity between nature and human society.

Several studies showed that agroforestry offers a wide range of environmental, economic and socio–cultural benefits. The tangible benefits of agroforestry are well-known and quantified but the intangible benefits are not quantified (Boerema et al., 2017). The most of agroforestry studies carried out focussed on tree crop interaction and economic evaluation, in the recent past some of the research were carried out on the ecosystem services of agroforestry (Jose, 2009). Among all the ecosystem services, most of the studies were carried out on the provisioning and regulating services, whereas cultural services were meagerly counted.

The study of cultural ecosystem services (CES) helps to address the complex relationship between humans and nature (Van Noordwijk, 2021; Kosanic and Petzold, 2020). CES became very significant in decision and policy-making at all levels of government, especially in payment for ecosystem services. However, the monetary value of CES is neglected due to the inherent or methodological challenges in quantifying them (Mao et al., 2020; Daniel et al., 2012; Dickinson et al., 2017). With this background, the present study focussed on quantifying the cultural values of M-PAM and the response/willingness of human society towards valuing CESs. The present study was conducted with two main objectives viz., 1. To create a set of indicators for two different types of questionnaires (Likert scale and yes/no) and ask respondents to choose which they prefer 2. Under technical assumptions, respondents asked to mention the willingness to pay (WTP) in monetary terms.

Material and methods

Study area

The study was conducted at Forest College and Research Institute, Mettupalayam (FC&RI), ((11°19′28″N, 76°56′18″E, 309 m MSL) Tamil Nadu, India, located at the foothills of Nilgiri, Western Ghats (*Fig. 1*).
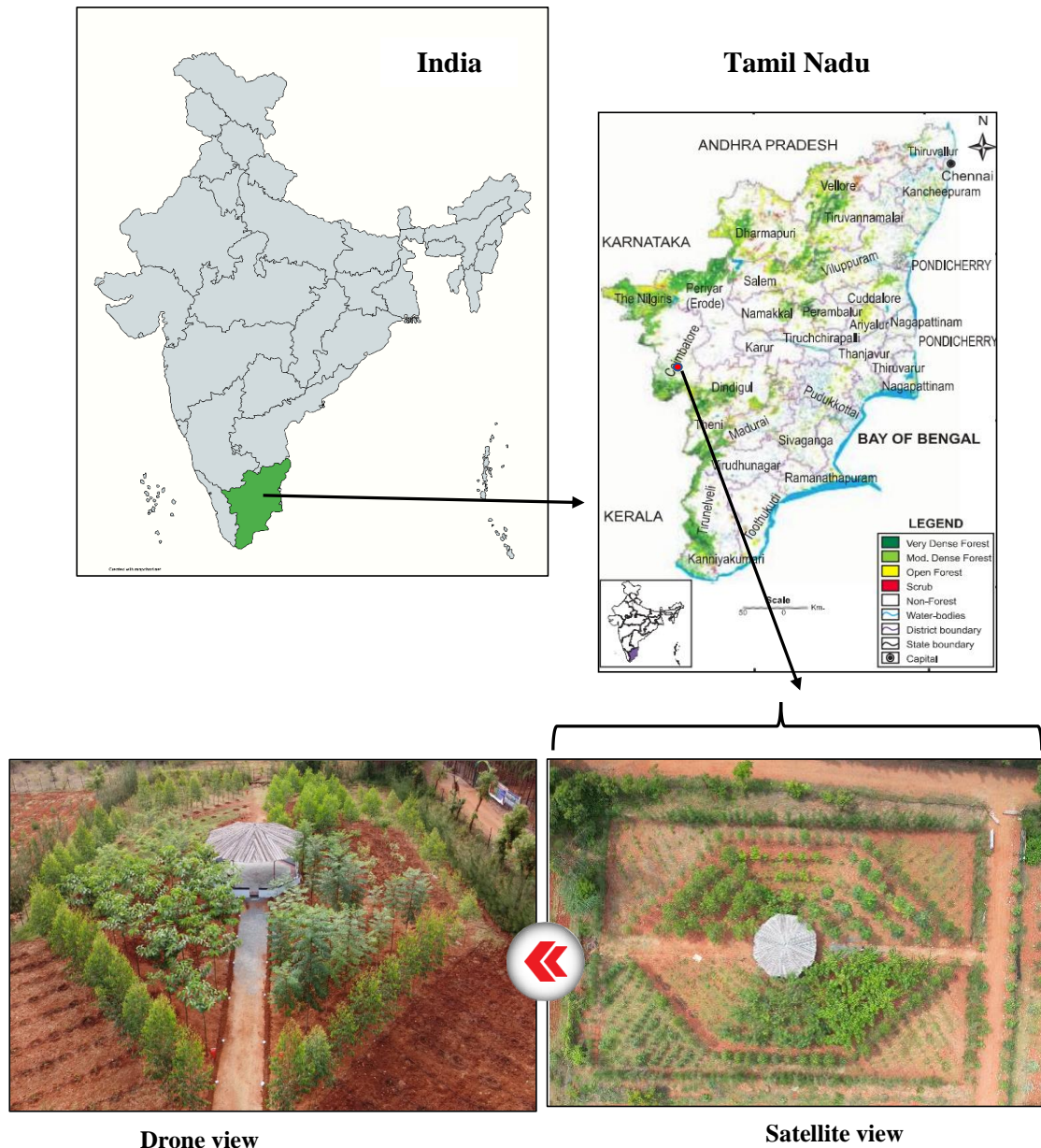
Figure 1. *Map and aerial view of Pulpwood Multifunctional Agroforestry at foothills of Niligiri, India*

The Pulpwood Multifunctional Agroforestry landscape was established in 2021 with a land cover of 0.60 acres in hexagonal shape comprising 8 pulpwood species. This model was developed for small landholders in order to enhance economic benefit to farmers and environmental benefit to society. The tree species selected for the study

were pulpwood species which are High Yielding Short Rotation clones amenable for paper manufacturing. The Hexagonal was divided into 6 quadrats each quadrat containing one species viz., *Neolomarckia cadamba*, *Dalbergia sissoo*, *Populus deltoides, Acacia hybrid, Gmelina arborea, and Melia dubia.* The outer boundary of the hexagonal was planted with *Eucalyptus urorgandis* and boundary of the field is covered with a single row of *Casuarina junghuhniana.* At four corners of the field consist of four perennial intercrops viz., Hybrid lemon (Food), *Jasminium grandiflora* (Flower), *Sesbania grandiflora* (Fodder) and *Morinda citrifolia* (Medicinal plant). Seasonal intercrop (vegetables and pulses) between the trees and cropping pattern changes based on the *Kharif* and *Rabi* seasons (*Fig. 2*).

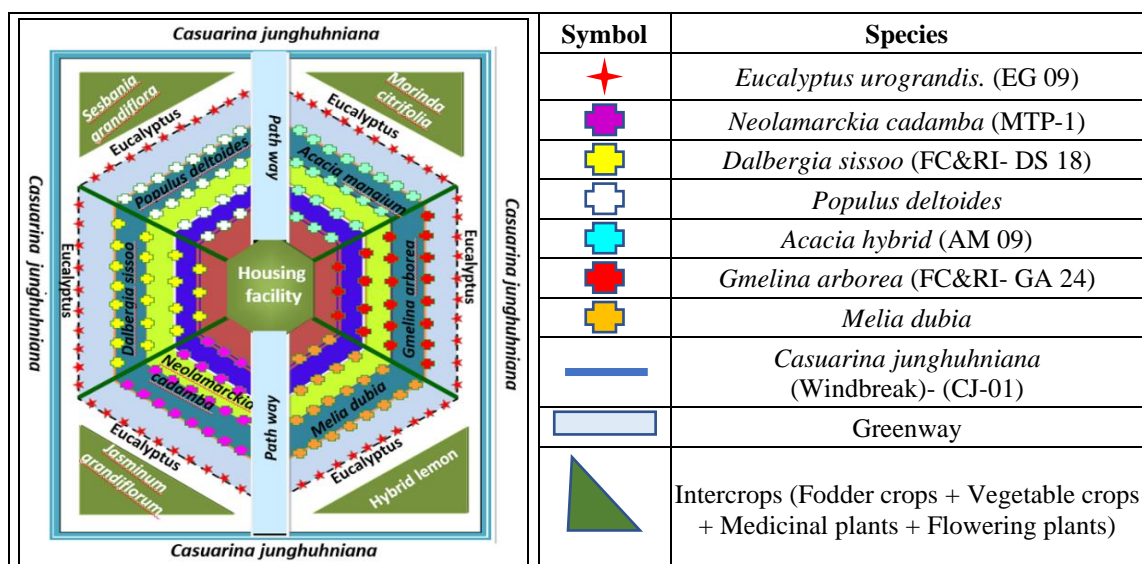| Symbol	Species
	Eucalyptus urograndis. (EG 09)
	Neolamarckia cadamba (MTP-1)
	Dalbergia sissoo (FC&RI- DS 18)
	Populus deltoides
	Acacia hybrid (AM 09)
	Gmelina arborea (FC&RI- GA 24)
	Melia dubia
	Casuarina junghuhniana (Windbreak)- (CJ-01)
	Greenway
	Intercrops (Fodder crops + Vegetable crops + Medicinal plants + Flowering plants)

Figure 2. The layout of Pulpwood Multifunctional Agroforestry

Data collection

Various conferences and stakeholder meetings were conducted at FC&RI including national and international involving farmers, students, entrepreneurs, government employees and local people. A total of 112 respondents visited PMAF during the last one year. From each conference, 10-15 respondents were given feedback. The visitors were made to understand the need of the PMAF and the ecosystem services it provides by explaining to them. Each of them given a questionnaire survey, which consists of 5 points Likert scale i.e. 5 – very important, 4 – moderately important, 3 – slightly important, 2 – less important and 1 – not important (eight statements; *Appendix A*).

The second questionnaire assisted in gathering data on the visitors' sociodemographic profile, including their age, sex, marital status, level of education, occupation, and income. Their responses to various aspects of the PMAF system were also recorded (*Appendix B*). Additionally, they were asked to state their WTP (willingness to pay) for CES in PMAF. In this study, the contingent valuation approach was used. The participants' travel distance was not taken into account because they were urged to investigate the potential of PMAF for agroforestry tourism.

Data analysis

The relative importance index (RII) was calculated using the method of Tam and Le (2009):

$$RII = \frac{\sum W}{A * N}$$ (Eq.1)

where W is the weight given to each component by the respondent, A the maximum weight and N is the total number of respondents.

Measure of sampling adequacy and regression analysis

To determine whether the data were appropriate for factor analysis, the partial correlation coefficient was used to perform the Kaiser-Mayer-Olkin (KMO) test and the Bartlett test. In order to evaluate the indicators recorded for various CES and observations (*Appendix A*), the factor extraction was assessed using principal component analysis (PCA) with varimax rotation. Scree plots and eigenvalues greater than 1.00 were used to identify the factors and to confirm them. Multiple linear regression analysis was used in the study to examine whether an MFA was appropriate for CES. WTP was used as the dependent variable, and other as explanatory variables.

Results

Socio-cultural characteristics of the participant

Among 112 participants, 57.14% were male and 42.86% were female. The age of respondents was categorized into five groups from less than 25 year age group to more than 56 years. The maximum number of respondents falls in the age group of 26-35 years (36.61%); followed by the 46-55 years (22.32) (*Fig. 3*) and more than 75% of participants are graduated; under graduation (45.54%), post-graduation (22.32%) and Ph.D. (8.04%). This showed that most of them were highly educated and could understand the questionnaire well and this also considered the opinion of less educated respondents (24.1%). Participants consist of government servants (48.21%), private employees (32.14%), and students (19.64%) and the income of the maximum number of respondents ranges from Rs. 50000-100000. Nearly half of the respondents were married (45.54%) and 56.46% are unmarried (*Fig. 3*).
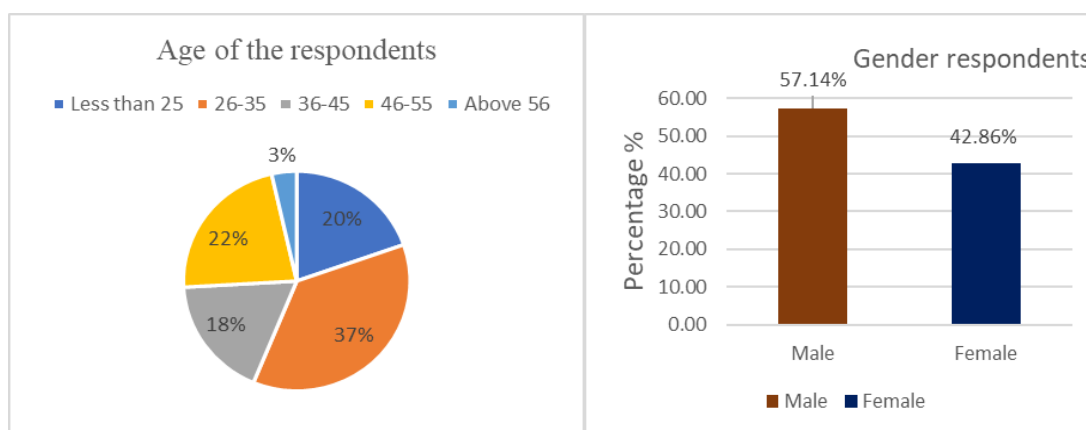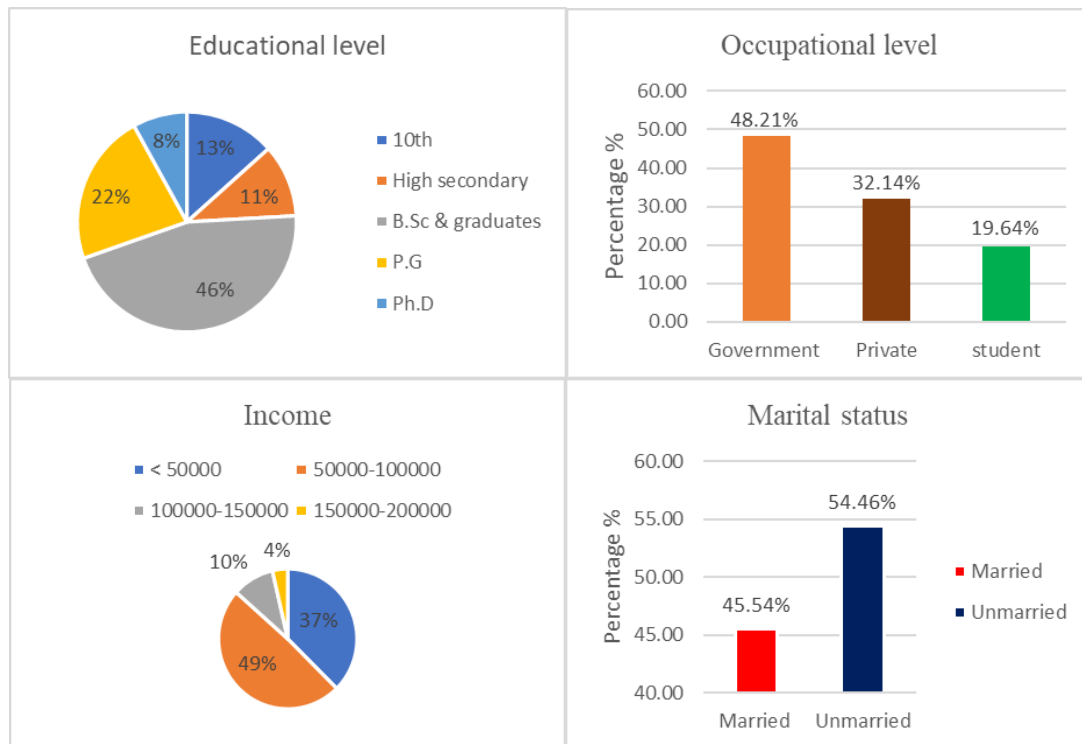
Figure 3. Socio-cultural background of the participants visiting PMFA

Cultural services of PMFA

From the five points Likert scale questionnaire survey, Relative Important Index (RII) was estimated (*Eq. 1*). Based on RII, it was found that out of all the CES indicators, spend some quality time ranked first (69.64%) followed by education and scientific knowledge (58.93%), emotional well-being (58.04%), walking (56.25%), relaxation (55.36%), inspiration (51.79%) and recreation (48.21%) by marking as very important ecosystem services from PMFA. But spiritual ranked the lowest and was marked as a moderately important ecosystem service of the PMFA (*Table 1*).

Table 1. Ranking of cultural ecosystem service (CES) indicators based on Likert-scale questionnaire

Indicators	Frequency	Relative importance index	Rank
Relaxation	62 (very important)	0.87	3
Recreation	54 (very important)	0.84	7
Spiritual	52 (moderately important)	0.82	8
Inspiration	58 (very important)	0.84	6
Education and scientific knowledge	66 (very important)	0.89	2
Emotional wellbeing	65 (very important)	0.86	4
Walking	63 (very important)	0.85	5
Spend some quality time	78 (very important)	0.91	1

The second part of the questionnaire survey consists of how respondents understand the importance and benefits of the PMFA land use system. The respondents (40.18%)

considered biodiversity and habitat as the most important benefit to society and 25% of the respondents considered food and biomass as important services from PMFA. More than 95% of participants feel that the PMFA model is acceptable for cultural services and they consider it will contribute to their emotional health and well-being, in addition, they feel a positive change after visiting PMFA (*Fig. 4*). Respondents were willing to visit frequently and 41.0% were interested to spend 2 h.
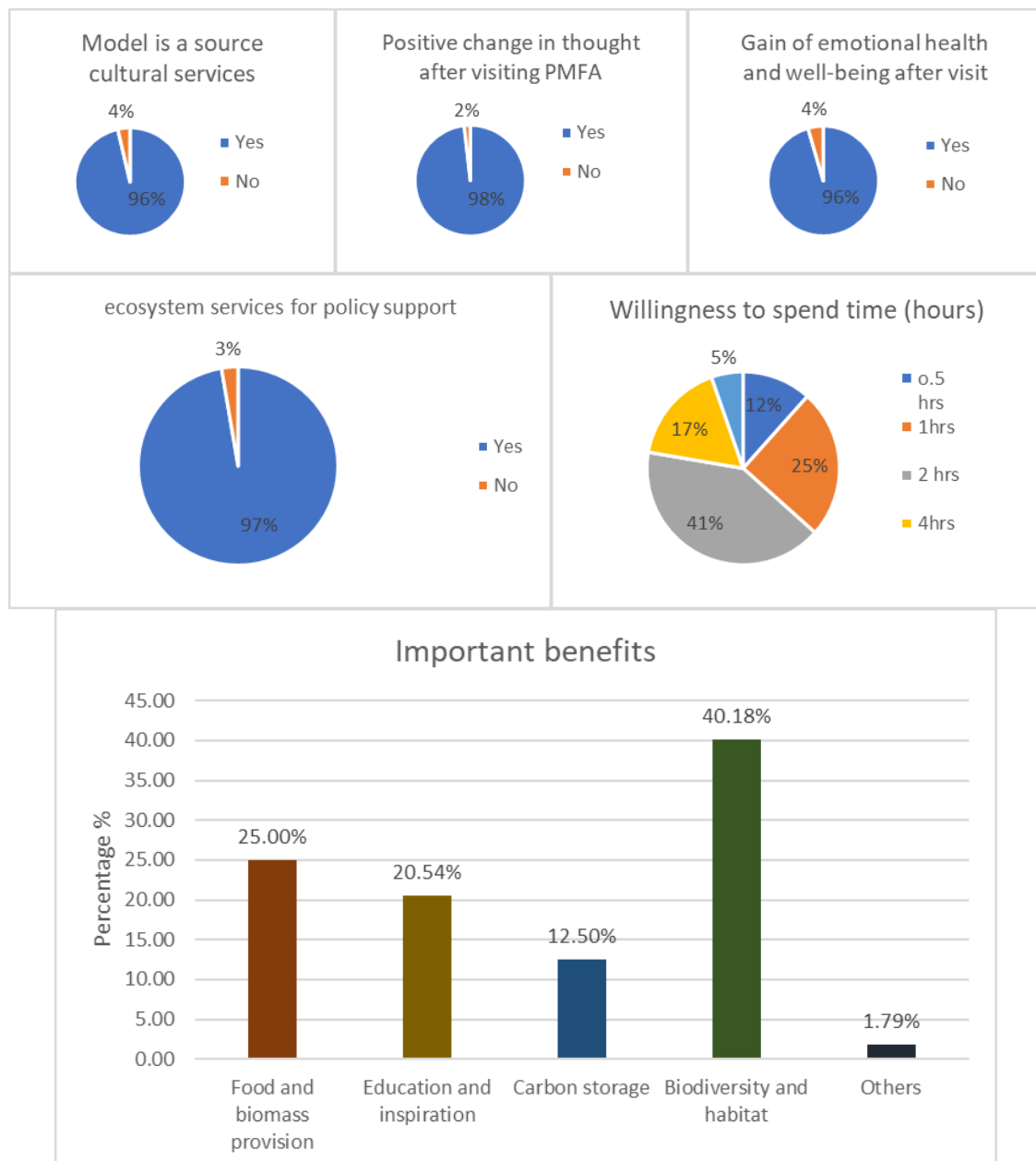
Figure 4. *Visitor's response towards a different aspect of PMFA*

Measuring sample adequacy

Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sampling adequacy analysis was conducted to measure the relationship between different variables and the suitability of

the data. The KMO coefficient was 0.933, which shows that there is a strong association between variables and confirms sampling adequacy. The sampling has a significance level of < 0.05 and a P value of < 0.001 as determined by the Barlett test of sampling (*Table 2*).

Table 2. *Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sampling adequacy analysis*

Kaiser–Meyer–Olkin measure of sampling adequacy		0.933
Bartlett's test of sphericity	Approx. chi-square	1.8293
	df	28
	Sig.	$p < 0.0001$

Respondent's attitude perceived from CES

PCA analysis from *Table 3* showed that there exists only one principal component (PC), which means the first component is strong enough and represents much of the variance (92%). The eigenvalue, which is the measure of the importance of principal components is 7.37 (eigenvalue > 1). This indicated most of the CES information can be obtained from a single PC which explains larger variation in the data and a strong correlation between the variables (*Fig. 5*).
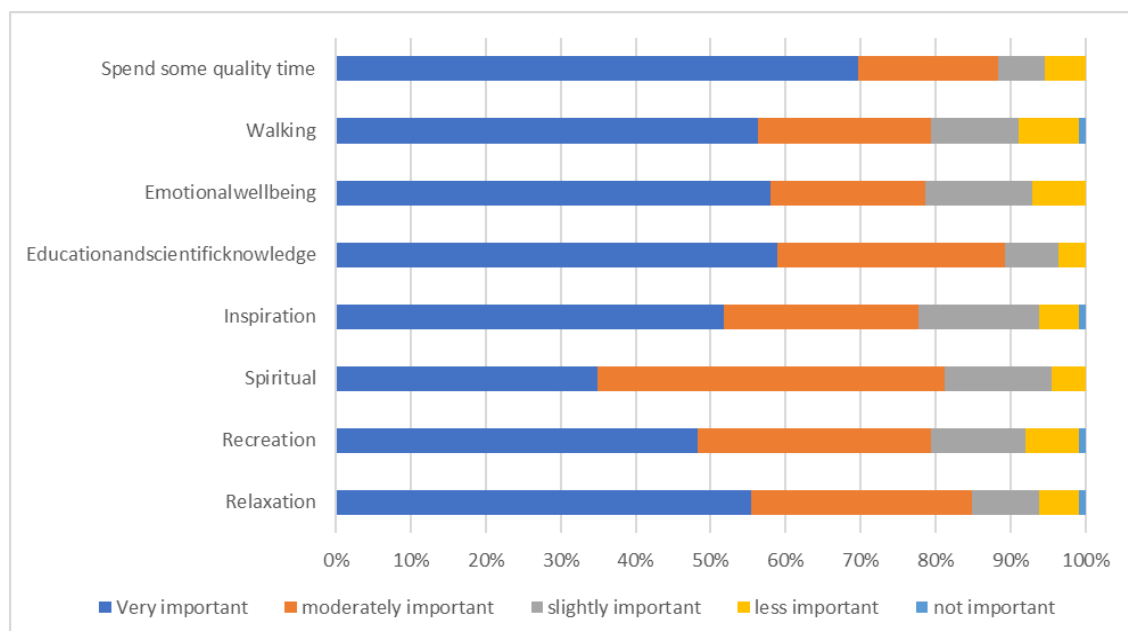
Figure 5. *Perception of respondents towards different indicators of CES*
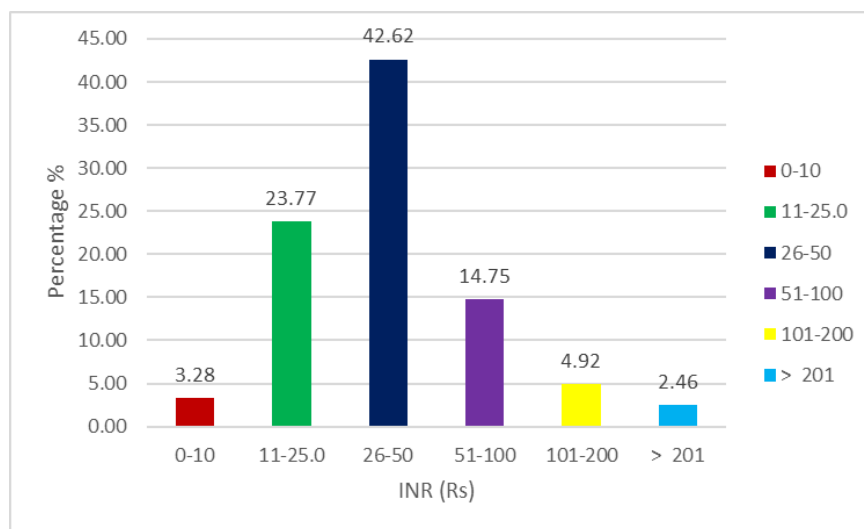
Willingness to pay

All the participants (112) showed interest in paying for the ecosystem services provided by PMFA and the average payment per visit was Rs. 48 (USD 0.58). 42.62% of the respondents were willing to pay in the range of Rs. 26-50 (*Fig. 6*). Multiple regression analysis showed that the PMFA model is a good fit for the valuation of CES (*Table 4*).

Table 3. *Principal component analysis for different components of Pulpwood Multifunctional Agroforestry (PMFA)*

S. No	Components	1
1	Relaxation	0.974
2	Recreation	0.971
3	Spiritual	0.907
4	Inspiration	0.974
5	Education and scientific knowledge	0.957
6	Emotional wellbeing	0.977
7	Walking	0.983
8	Spend some quality time	0.933
	Eigen values	7.37
	% variance	92.127

Rotation method: Varimax with Kaiser normalization

Figure 6. *Participants willingness to pay for visit to PMFA*

Table 4. *Multiple regression analysis and willingness to pay for CES*

Variables	Coefficient	Standard value	T-ratio
Intercept/constant	-72.13	26.56	-2.72
Age	28.89**	5.01	5.76
Gender	8.73	11.00	0.79
Marital status	36.07	10.04	3.59
Income	8.94**	7.08	1.26
Education	7.92	5.05	1.57
Occupational level	-21.66	7.48	-2.90
R	0.77		
R^2	0.60		
Adjusted R^2	0.57		
F-Value	25.84		
WTP	Rs. 48/Visit		

**Significant at 5% and 1% level

Discussion

People's perception of ecosystem services provided by different land use systems becomes important in land use policies (Schmidt et al., 2017). This study assessed participants' perceptions of CES of PMFA and the results of socio-cultural valuation revealed, how the CES values change with the socio-demographic background of the participants, such as age, academic background, gender, income and occupation (Plieninger et al., 2013; Van Berkel and Verburg, 2014). Most of the respondents were highly educated and middle-aged and they showed a positive perception of CES by the PMFA land use system. Respondents appreciated the nonmaterial benefits of the PMFA landscape, which confirms that the model is suitable for CES and similar results were found in Multifunctional agroforestry landscapes (Keerthika et al., 2021). Our research supports the notion that people connect cultural services to personal well-being and emotional health (*Fig. 5*). Spending quality time was found most important due to the aesthetic and recreational benefits enjoyed while visiting PMFA and because of their educational background, most respondents preferred acquiring scientific knowledge (*Fig. 5*). Biodiversity and habitat were found more beneficial to participants because biodiversity enhances other cultural services (Lele et al., 2013). However spiritual value is preferred less by respondents due to the absence of sacred trees and temples in PMFA, which can be confirmed by a study conducted by (Zoderer et al., 2016), who claimed that while spirituality and cultural heritage showed less importance, recreational opportunities were given more weight by respondents. But there is a close association between RII values and CES revealed significant overlap between individual indicators, suggesting that the respondents were unable to distinguish between different cultural services (Plieninger et al., 2013; Keerthika et al., 2021).

Various studies on landscape preferences have addressed the socio-demographic and cultural aspects of the people who express those preferences (Koshaka et al., 2021) and the cultural association between humans and nature has been studied on different landscapes like the role of landscape elements in agricultural landscapes' aesthetic and recreational values in Netherland (Zanten et al., 2014), recreational values in the Agroforestry Territories of Tuscany, Italy (Fagarazzi et al., 2021), socio-cultural valuation of ecosystem services in Pentland Hills regional park in Scotland (Schmidt et al., 2017), primitive wood pastures in Hungary and Romania (Varga et al., 2015, 2014). Which have related the importance of cultural services to historical sites, cultural events, tourist hospitality, leisure pursuits, and elements of local identity. Under the Indian context perceptive of the understanding of cultural ecosystem services of agroforestry is lacking (Keerthika et al., 2021). However, people have a positive attitude towards nature and do without any importance to specific landscapes (Kaszyńska et al., 2000). This is in accordance with our results, where none of them have a negative perception of CES of PMFA, even though there was a wide range of socio-demographic respondents.

Payments for ecosystem services (PES) arise when beneficiaries of an ecosystem service pay for the services provided by the environment (Gomez-Baggethun et al., 2010). In recent times the PES has gained global importance in policymaking and assures that there will always be a reason to provide ecosystem services, even in the face of ongoing competition from other land uses (Engel et al., 2008). PES has also helped financial incentives to the local providers and thus helped to improve the livelihood of the people. In the present study WTP was used as PES tool for assessing perception of beneficiaries towards CES provided by PMFA. Study showed the

relationship between income and WTP, which states as income of the person increases the WTP also increases (Platinia and Rizzo, 2018; Nie et al., 2019). However, in general education level has more influence on WTP. Average WTP in the current study was Rs. 48/visit and respondents were accepted as entrance fee, similar findings was observed in literatures (Lal et al., 2017; Brown et al., 2015). Like PMFA model, CES of Multifunctional Agroforestry model has been studied but still, it need to be replicated in different regions in order to interpret broader opinions of people towards CES and to overcome the limitations of the current study. Overall present study highlights the significance of CES of PMFA.

Conclusion

There are socio-cultural aspects of human–environment relations in ecosystem service evaluation that are being ignored to account for it. Our study on the evaluation of CES of PMFA allowed us to reveal some aspects of non-material benefits that are not considered for the conceptualization of values. The present study concludes that socio–demographic profile of the individual influences the CES and society is willing to pay for the CES provided by PMFA. Overall respondents like to spend more time, acquire scientific knowledge and enjoy the biodiversity habitat of the area.

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APPENDIX

Appendix A. Likert scale questionnaire for evaluating cultural ecosystem services

S. No	Indicators	Meaning understood	Very important	Moderately important	Slightly important	Less important	Not important
			5	4	3	2	1
1	Relaxation	Visiting MPA provides areas to exercise and relax					
2	Recreation	Visiting MPA provides a place for enjoyment or pleasure and beauty					
3	Inspiration	Visiting MPA stimulates creative ideas and thoughts					
4	Spiritual	Visiting MPA connects to people's thoughts and beliefs					
5	Education and scientific knowledge	Visiting MPA provides scientific information about identification and					

		importance of different components viz., trees, flowers, fruits, vegetables, fodders etc.					
6	Emotional well being	Visiting MPA positively stimulates good mental health of an individual					
7	Walking	Visiting MPA creates environment like walking in nature					
8	Spend some quality time	Visiting MPA serves as meeting point for family and friends					

Willingness to pay (WTP) per visit - -------------------
*MPA- Multifunctional Pulpwood based Agroforestry

Appendix B. *Questionnaire for CES*

Questionnaire for cultural services

Socio-demographic profile of the respondents

1. Name:
2. Age
   a) Less than 25
   b) 26-35
   c) 36-45
   d) 46-55
   e) Above 56
3. Gender
   a) Male
   b) Female
4. Marital status
   a) Married
   b) Unmarried
5. Education
   a) < 10th standard
   b) 10th standard
   c) Higher Secondary
   d) B.Sc/Gardaute
   e) P.G
   f) Ph.D
   g) Any other……………………..
6. Occupation
   a) Government service
   b) Private
   c) Any other_____
7. Income (Rs.)
   a) < 50000 (< 672. 48 USD)
   b) 50000-100000 (< 672.48 – 1344.95 USD)
   c) 100000-150000 (1344.95 USD – 2017.43 USD)
   d) 150000-200000 (2017.43 – 2689.81 USD)

Questions on Pulpwood based Agroforestry

8. Name the benefit you consider most important for society?
   a) Food and biomass provision
   b) Education and inspiration
   c) Carbon storage
   d) Biodiversity and habitat
   e) Others (specify)
9. Do you feel this model is acceptable for cultural services?
   a) Yes
   b) No (Reason)
10. Do you feel positive change after visiting MPA?
   a. Yes
   b. No
11. Does it contribute to emotional health and well-being after visiting PA?
   a) Yes
   b) No
12. Can we intend to use ecosystem services for policy support and improve decision making?
   a) Yes
   b) No
   c) Others (Specify)
13. How long do you anticipate to spend here?
   a) 30 min
   b) 1 hours
   c) 2 hours
   d) 4 hours
   e) Others (specify)
14. Should society pay for delivery of environmental services? In what way?