

# Understanding cultural ecosystem services of multifunctional agroforestry: a study from the foothills of the Nilgiris, Western Ghats, India

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Numerous studies have underlined the benefits of cultural services from different landscapes and acknowledge the non-material benefits linking society and nature. However, cultural services from agroforestry have not been reported. Therefore, the present study was conducted in multifunctional agroforestry (MFA) comprised of 24 tree species and 8 intercrops established at the Forest College and Research Institute, Mettupalayam, Tamil Nadu, India. Four workshops were conducted and a total of 105 respondents were asked to fill two sets of questionnaires regarding their perception of cultural ecosystem services in MFA. Among the selected components, education and scientific knowledge (0.90) ranked first, followed by relaxation (0.86) and walking (0.84). Results from principal component analysis revealed that three components, viz. relaxation, education and scientific knowledge, and inspiration accounted for 56.60% of the variance. Respondents' willingness to pay was Rs 33/visit on an average and multiple regression analysis indicated that the MFA model was a good fit ( $R^2=0.79$ ) for agroforestry tourism. The results indicate that MFA provides scope for agroforestry tourism, which will be an additional source of income for small and marginal-scale farmers.

**Keywords:** Aesthetic and recreation, agroforestry tourism, cultural ecosystem services, multifunctional agroforestry, willingness to pay.

CULTURAL ecosystem services (CES) are 'the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences'<sup>1</sup>. Valuing cultural services linked to human society and nature is key for achieving the sustainable development goals (SDGs) of the United Nations, and it highlights the importance of addressing material and non-material benefits<sup>2</sup>. CES related to agroforestry landscapes are gaining attention due to their significant role in improving biodiversity and income of local communities<sup>3</sup>. Agroforestry systems are

paradigmatic of agro-ecological land-use systems and are defined as a landscape unit that combines the aspects of both agriculture and forestry<sup>4</sup>. Globally, 1.2 billion people practice agroforestry<sup>5</sup> in about 10% of the total agricultural lands<sup>6</sup>. In India, the area under agroforestry is estimated to be about 8.2% (25.32 m ha) of the total geographical area of the country<sup>7,8</sup>.

Agroforestry systems are diverse; some studies focus on specific and localized traditional systems. However, newly developed models like Multifunctional agroforestry (MFA) have become popular, especially in terms of multifaceted benefits<sup>9</sup>. The concept of MFA recognizes agroforestry as a multiple-output activity producing not only commodities but also non-commodity outputs such as environmental and cultural services. Thus, MFA connects different aspects of science, policy and practice, demonstrating the societal benefits<sup>4</sup>.

Several global and regional-level reviews have shown that agroforestry offers a wide range of environmental, socio-cultural and economic benefits at the landscape level<sup>10,11</sup>. However, the complexity of agroforestry landscapes needs to be examined through a socio-ecological lens, which includes identifying interactions among the multiple ecosystem functions and services and related drivers, processes and impacts<sup>12,13</sup>. MFA-based tourism is emerging as a new concept for improving the livelihood of farm owners, additionally providing aesthetic and scientific knowledge to the tourists. It plays an important role in the well-being of people, providing high-quality experience for tourists, sensitivity to culture, understanding the local flora and fauna, and overall environmental conservation.

Among all ecosystem services, much of the literature has focused on provisioning and regulating services, whereas cultural services have been relatively neglected<sup>14</sup>. This may be due to the methodological or inherent difficulties in quantifying them<sup>15,16</sup>. The framework for non-material benefits of CEA under the millennium ecosystem assessment includes spiritual, religious, traditional knowledge, education, inspiration, aesthetic, scenic beauty, social relations, sense of place, cultural heritage, and recreation and ecotourism services. Such services are completely

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determined by human perceptions and consciousness, knowledge and socio-cultural developments linked with nature. It is also important to identify how these benefits are understood because the management of such services is essential for sustainability. Furthermore, the opinions regarding cultural services differed among the respondents, and they change over time<sup>17</sup>.

CES is taking a significant debate for integration in decision-making and government policies especially in terms of payment towards aesthetic and recreation benefits. However, it is poorly reflected in monetary terms. Therefore, there is a need to understand how and what type of service a person is experiencing, and how these experiences change according to personal characteristics, viz. age, gender, education, occupation and preference of MFA landscapes. The usual agroforestry practice consists of one or two tree and crop species that lack diversity and thus fail to attract tourists. However, an MFA system serves several purposes, including income enhancement, environmental sustainability, cultural services, human wellness and an opportunity for ecotourism<sup>9</sup>. Against this background, the present study was conducted to evaluate the relationship of people with nature using the opinions of the respondents regarding MFA landscapes. The two main objectives of this study were: (i) to develop a set of indicators in two types of questionnaire (Likert scale and yes/no) and request the respondents to mark their choice and (ii) to mention the respondents' willingness to pay (WTP) in monetary terms, under technical assumptions.

## Materials and methods

### Study area

The study was undertaken during 2019–20 at the Forest College and Research Institute, Mettupalayam (11°19'33"N, 76°56'16"E, 300 m amsl), Tamil Nadu, India located in the sylvan surroundings of the foothills of the Nilgiris. The mean annual precipitation of Mettupalayam is 693–700 mm. Winter is from December to February, with an average temperature of 15–18°C. Summer is from March to May, with a maximum temperature of 35°C and a minimum of 30°C.

The circular-shaped MFA landscape chosen for the study covers an area of 0.75 acres and was established in 2018. It was divided into four equal quadrats and comprising 24 tree species and 8 intercrops (Figure 1). This unique model was developed for income generation and to establish agroforestry parks, especially to help small farmers. Each circle of tree species within the model had unique importance, viz. high-value timber circle (sixth), timber circle (fifth), plywood (fourth), medicinal value (third), fruits (second), *Moringa* circle (first), and the border consisting of tree-borne oilseeds. Quadrat I consisted of *Jasminum grandiflorum* and *Jasminum officinale*,

quadrat II vegetables (cropping pattern changes for *kharif* and *rabi* seasons), quadrat III *Murraya koengii* and *Nerium oleander*, and quadrat IV contained fodder such as Guinea grass and *Desmanthus*. Despite growing academic interest in agroforestry, to the best of our knowledge, a circular MFA model has not been previously explored for 'agroforestry tourism'.

### Data collection

For the study, four agroforestry workshops were conducted – including international and national involving farmers and local people as well. A total of 105 respondents (about 25 from each workshop) visited the MFA landscape, and the need for establishing a model was explained to the tourists. The respondents were presented with two types of questionnaire (prepared in consultation with economists, social scientists and those involved in natural resource management, and pre-tested with undergraduate forestry students). The first questionnaire used the five-point Likert scales<sup>18</sup>, i.e. 5 – very important, 4 – moderately important, 3 – slightly important, 2 – less important and 1 – not important (Eight statements; Appendix 1). The second questionnaire helped to collect information on the socio-demographic profile (age, sex, marital status, education details, occupation and income) of the visitors, and their response to different aspects of the MFA system was recorded (Appendix 2). They were also asked to express their willingness to pay (WTP) for CES in MFA. The contingent valuation method was adopted in this study. Since the participants were encouraged to explore the possibilities of MFA for agroforestry tourism, the distance travelled by them was not taken into consideration.

### Data analysis

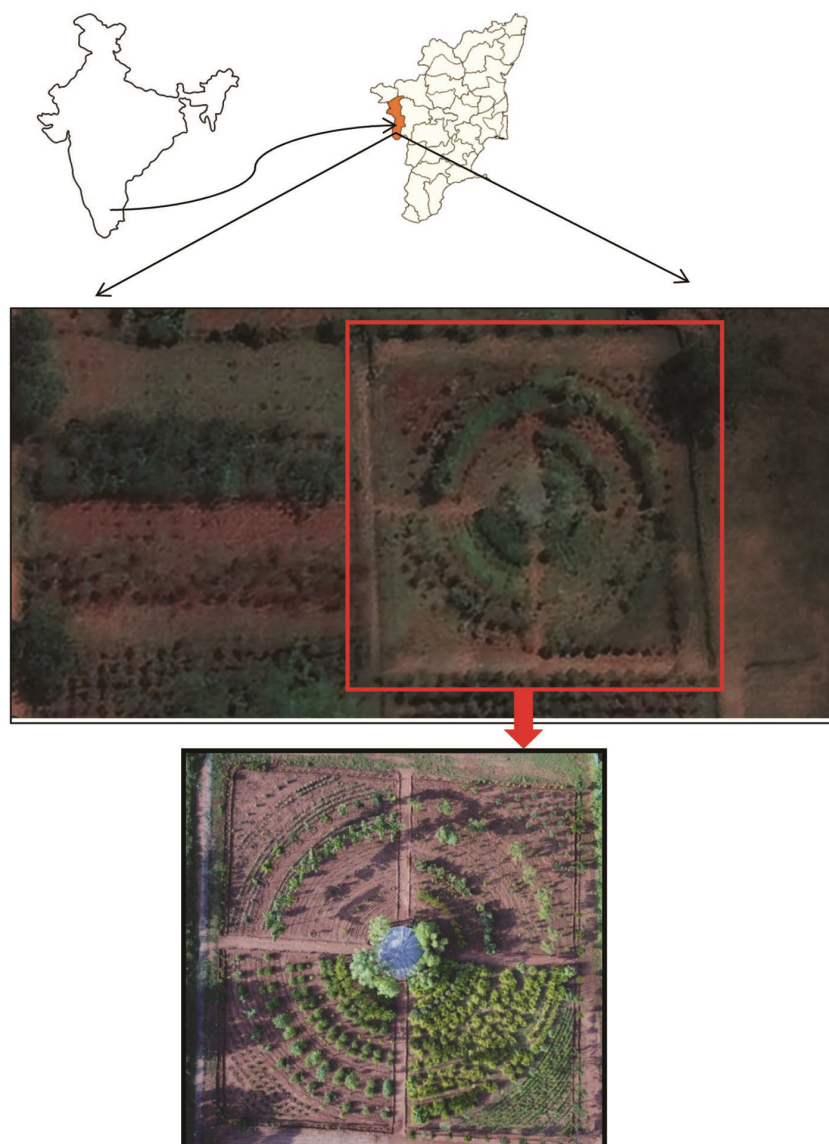
The questionnaire data were entered into an excel database and exported to IBM SPSS software. The relative importance index (RII) was calculated using the method of Tam and Le<sup>19</sup>

$$RII = \sum W / (A * N),$$

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

### Measure of sampling adequacy and regression analysis

Kaiser–Mayer–Olkin (KMO) test and Bartlett test were performed using partial correlation coefficient, to assess the suitability of data for factor analysis. The factor extraction was evaluated using principal component analysis



**Figure 1.** Aerial view of multifunctional agroforestry (MFA) at the foothills of the Nilgiris, Tamil Nadu, India.

(PCA) with varimax rotation to assess indicators recorded for different CES and observations (Appendix 1). The factors were determined using eigenvalues greater than 1.00 and confirmed with scree plots. The study adopted multiple linear regression analysis to test the suitability of an MFA for CES. WTP was taken as the dependent variable and other explanatory variables as independent variables.

## Results

### *Characteristics of the respondents*

Out of 105 respondents, 62.9% were male and 37.1% were female. The participants were predominantly in the age group of 46–55 years (46.7%), followed by 36–45 years

(27.6%). They were highly educated with 79% holding degrees; under graduate (15.2%), postgraduate (26.7%) and Ph D (37.1%), which indicates that most of the participants could understand the questionnaire well (Figure 2). However, this study has also considered the opinions of less educated participants (21%). Most of the participants were employed in government organizations (87.65%), followed by private organizations (12.4%). The income of the participants was mainly in the range Rs 50,000 and 100,000 (47.6%) per month per family, which shows that their quality of life was relatively good (Figure 2).

### *Cultural services of MFA*

Among the indicators of CES, education and scientific knowledge ranked first with 83% of respondents marking

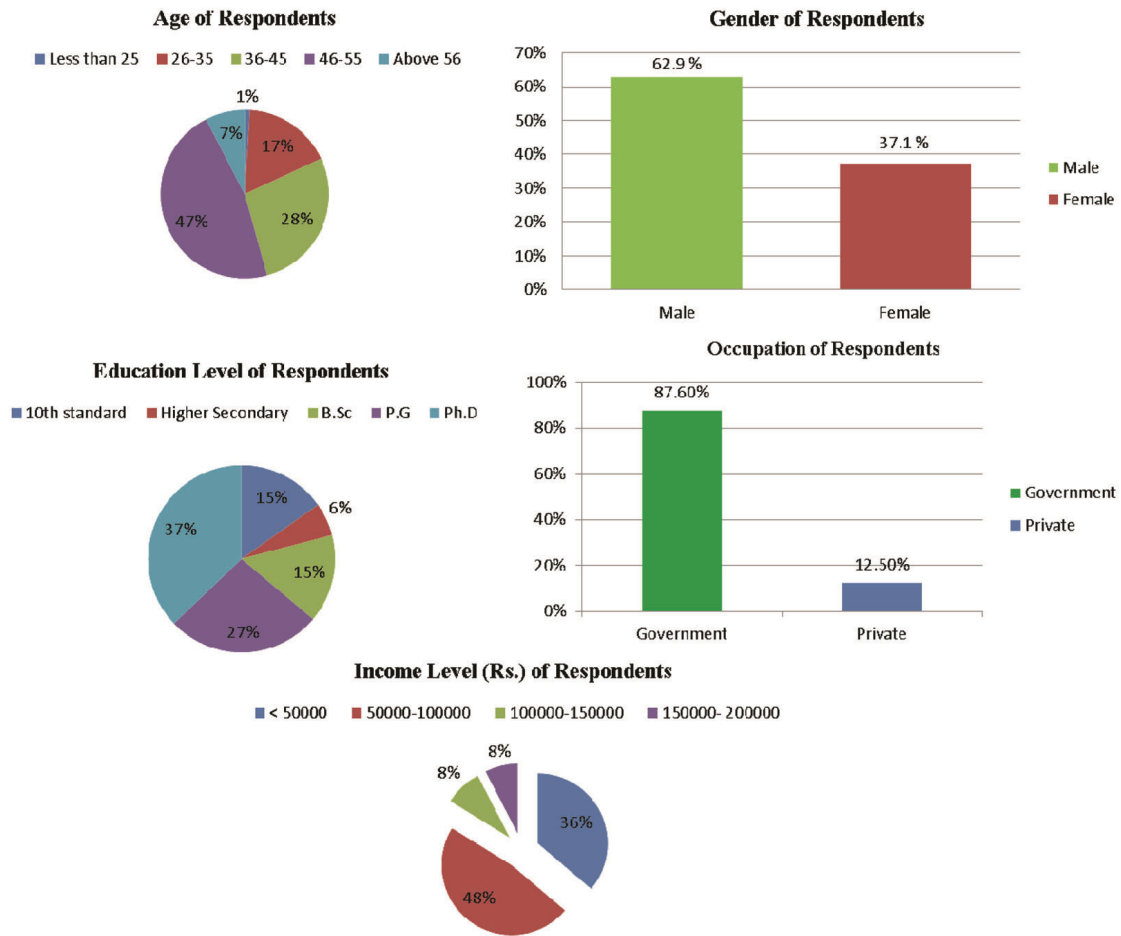


Figure 2. Socio-demographic profile of the respondents visiting MFA.

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

Indicators	Frequency	Relative importance index	Rank
Relaxation	61 (very important)	0.86	2
Recreation	47 (very important)	0.81	6
Spiritual	51 (moderately important)	0.79	7
Inspiration	62 (very important)	0.83	5
Education and scientific knowledge	83 (very important)	0.90	1
Emotional well-being	50 (moderately important)	0.77	8
Walking	49 (very important)	0.84	3
Spending quality time	52 (very important)	0.83	4

it as very important; this indicates that MFA is viewed mainly as a source for acquiring scientific information. Relaxation was ranked the second with a relative importance value of 0.86 followed by walking (0.84), whereas spiritual (0.79) and emotional well-being (0.77) ranked the lowest and were moderately important to the respondents (Table 1).

The second part of the questionnaire explains the importance and understanding of the respondents regarding

the MFA landscapes (Figure 3). From the response of the visitors, food and biomass provision (35.2% of respondents), as well as biodiversity and habitat conservation (34.3% of respondents) were the most important benefits for society obtained from MFA. Majority of the visitors considered that MFA could provide emotional health and well-being, as well as positive thinking. Therefore, it was regarded as a good source of CES, i.e. a place to visit frequently and spend quality time. Most of the respondents

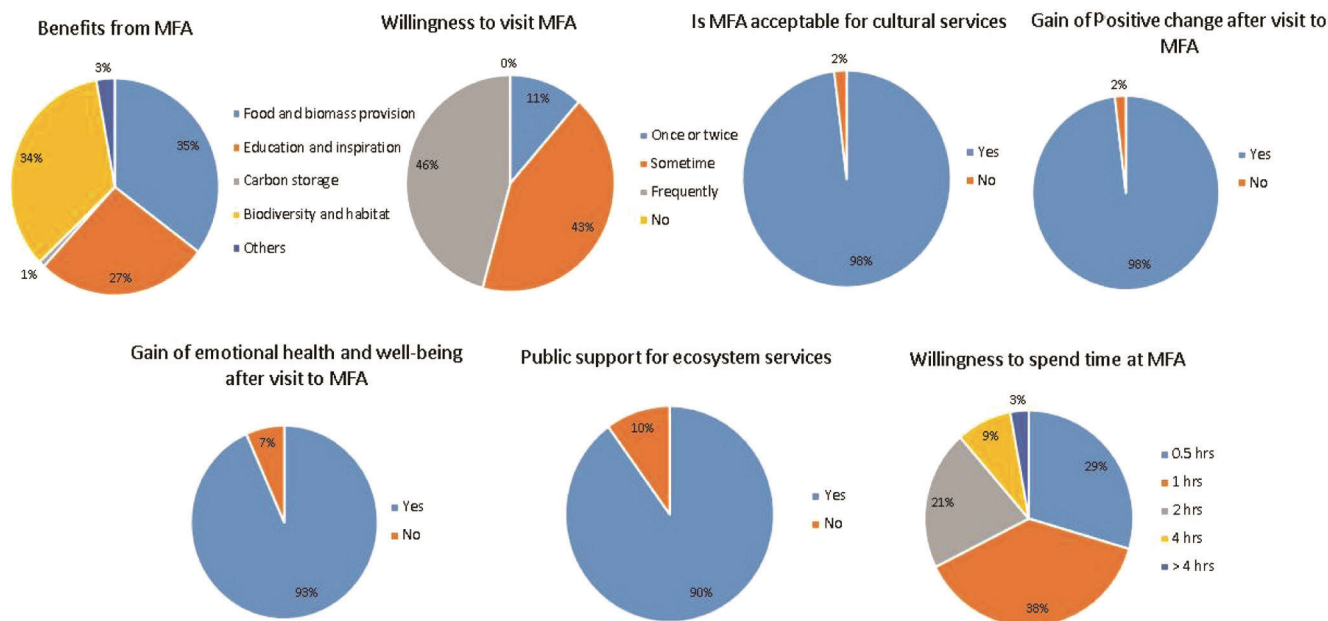


Figure 3. Response of visitors towards different aspects of MFA.

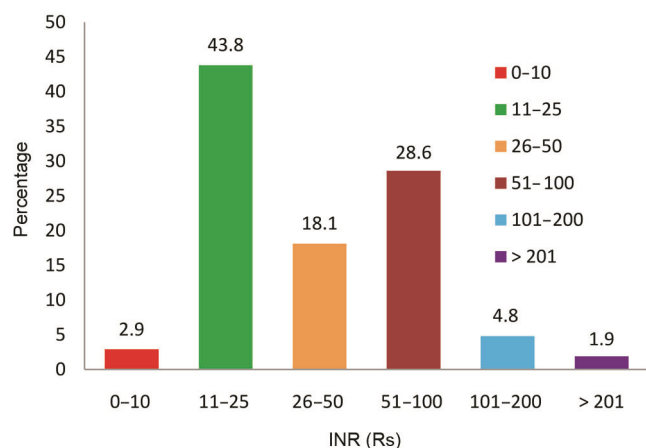


Figure 4. Willingness to pay for CES in MFA.

expressed their desire to visit MFA frequently (46% of respondents) and were willing to spend one hour (38% of respondents; Figure 3).

*Measuring sample adequacy*

The relationship between different variables and suitability of data was complemented with the Bartlett test of sphericity and KMO test. The KMO coefficient was 0.61, which indicates reasonable association between variables and confirms sampling adequacy. As per Bartlett test of sampling, the sampling shows significance of <0.05 and P value of <0.001 (Table 2).

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

Kaiser–Meyer–Olkin measure		0.615
Bartlett’s test of sphericity	Approximate chi-square	93.903
	Df	28
	Significance	P < 0.001

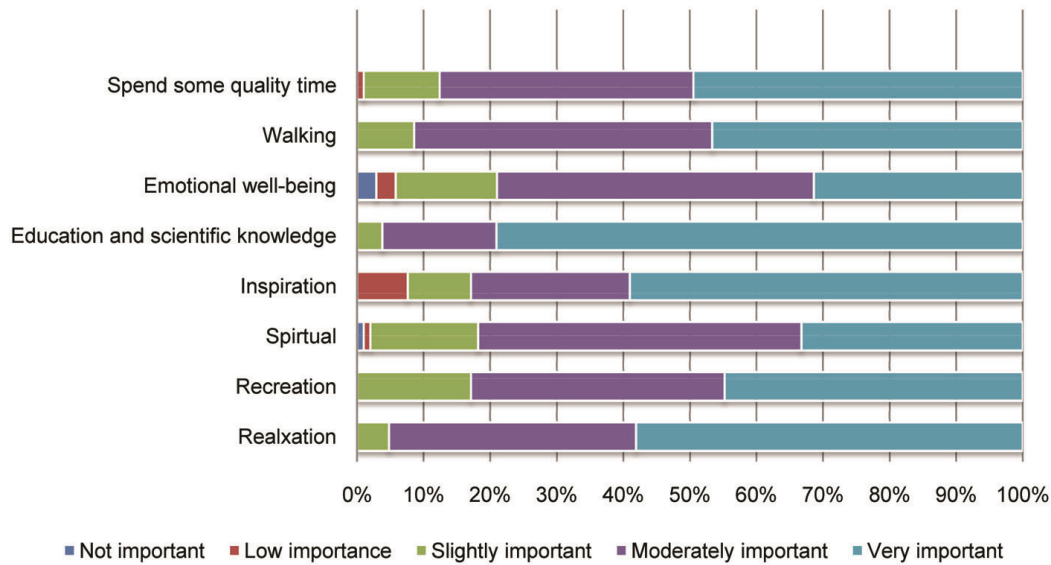
Table 3. Principal component analysis for different components of multifunctional agroforestry (MFA)

Components	1	2	3
Relaxation	0.677	0.008	0.030
Education and scientific knowledge	0.672	0.009	0.092
Inspiration	0.643	0.014	0.192
Spending quality time	0.638	0.385	-0.103
Emotional well-being	-0.135	0.813	0.216
Recreation	0.253	0.786	-0.006
Spiritual	0.199	0.154	0.752
Walking	0.006	0.016	0.746
Eigen values	2.23	1.24	1.05
% Variance	27.72	15.72	13.16
Cumulative variance	27.72	43.44	56.60

Rotation method: Varimax with Kaiser normalization.

*Respondents attitude perceived from CES*

Table 3 provides the results from PCA on different components (indicators) of CES. Three components showed eigenvalue greater than 1, viz. relaxation (2.23), education and scientific knowledge (1.24), and inspiration (1.05) and exhibited a total variance of 56.60%. This



**Figure 5.** Perception of respondents toward indicators of cultural ecosystem service (CES) in MFA based on Likert scale.

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

Variables	Coefficient	Standard value	T-ratio
Intercept	-60.53	18.66	-3.24
Age	0.77**	0.23	3.28
Marital status	-8.35	5.99	-1.39
Family size	1.73	1.88	0.91
Income	0.00**	0.00	14.86
Gender	4.79	3.32	1.44
Perception towards MFA	0.82	3.02	0.27
$R^2$	0.80		
Adjusted $R^2$		0.79	
F-value		67.30	
WTP		Rs 33/visit	

\*\*Significant at 5% and 1% level.

shows that most of the CES information can be extracted from these three components. The first component explains 27.72% of the variance and CES grouped in loading were education and scientific knowledge, inspiration, and spending quality time. There were moderate to strong correlations between the first four components and the first component (relaxation) and a strong correlation between emotional well-being, recreation, and the second component (education and scientific knowledge; Table 3).

### Willingness to pay

The average amount that the respondents were willing to pay for enjoying CES provided by MFA was Rs 33/visit (USD 0.44). Also 43.8% of the respondents were willing to pay between Rs 11 and 25 (Figure 4). The  $R^2$  value of 0.79 from multiple linear regression indicates that the model is a good fit for studying MFA. In the socio-demo-

graphic profile, age and income were found significant at 5% and 1% levels (Table 4).

### Discussion

This study assesses CES that the respondents perceive and enjoy while visiting an MFA. Different studies have shown variances in the socio-demographic profile, such as gender, age, educational background and nature of employment of the respondents, etc.<sup>20,21</sup>. The results obtained from the present study indicate that each respondent perceives cultural services based on his/her socio-demographic profile. Most of the participants were middle-aged and educated; they readily appreciated the MFA landscape for non-material benefits. Our findings confirm that people relate cultural services to individual well-being. However, acquiring scientific information was the foremost priority of the respondents, which is because of their educational background. From the indicators of CES, most of the respondents could enjoy other benefits, viz. relaxation, walking, spending quality time and inspiration (Figure 5). The absence of religious trees and temples in the MFA indicates less importance of cultural services such as spiritual and emotional well-being. These results are in agreement with those of Zoderer *et al.*<sup>22</sup>, who reported that recreational opportunities were given more importance by the respondents, whereas spirituality and cultural heritage showed less importance. Although there was a close association between the RII values, the assigned CES showed considerable overlap between individual indicators, implying that the respondents could not categorize one cultural service from another. These findings are in agreement with those of Plieninger *et al.*<sup>20</sup> and Daniel *et al.*<sup>15</sup>.

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**Appendix 1.** Likert scale questionnaire for evaluating cultural ecosystem services (CES)

Indicators	Meaning understood	Very important	Moderately important	Slightly important	Less important	Not important
		5	4	3	2	1
Relaxation	Visiting multifunctional agroforestry (MFA) provides areas to exercise and relax					
Recreation	Visiting MFA provides a place for enjoyment, pleasure and beauty					
Inspiration	Visiting MFA stimulates creative ideas and thoughts					
Spiritual	Visiting MFA connects to people's thoughts and beliefs					
Education and scientific knowledge	Visiting MFA provides scientific information about identification and importance of different components, viz. trees, flowers, fruits, vegetables, fodders, etc.					
Emotional well-being	Visiting MFA positively stimulates good mental health of an individual					
Walking	Visiting MFA creates an environment like walking with nature					
Spend some quality time	Visiting MFA serves as a meeting point for family and friends					

Willingness to pay (WTP) per visit in rupees.

**Appendix 2.** Questionnaire for CES

Socio-demographic profile of the respondents	Questions on multifunctional agroforestry system (MFA)
1. Name:	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)
2. Age (years): (a) Less than 25 (b) 26–35 (c) 36–45 (d) 46–55 (e) Above 56	9. Do you feel this model is acceptable for cultural services? (a) Yes (b) No (reason)
3. Gender: (a) Male (b) Female	10. Do you feel positive change after visiting MFA? (a) Yes (b) No
4. Marital status: (a) Married (b) Unmarried	11. Does it contribute to emotional health and well-being after visiting MFA? (a) Yes (b) No
5. Education: (a) 10th standard (b) Higher secondary (c) B Sc (d) PG (e) Ph D	12. Can we intend to use ecosystem services for policy support and improve decision making? (a) Yes (b) No (c) Others (specify)
6. Occupation: (a) Government service (b) Private	13. How long do you anticipate to spend here? (a) 30 min (b) 1 hour (c) 2 hours (d) 4 hours (e) Others (specify)
7. Income (Rs): (a) <50,000 (<672.48 USD) (b) 50,000–100,000 (<672.48–1344.95 USD) (c) 100,000–150,000 (1344.95–2017.43 USD) (d) 150,000–200,000 (2017.43–2689.81 USD)	14. Should society pay for the delivery of environmental services? In what way?

Researchers have provided novel concepts of linking nature and people – in the agricultural landscapes of Romania and Germany<sup>23,24</sup>, agroforestry of dehasas in Western Spain<sup>25</sup>, ancient wood pastures in Romania and Hungary<sup>26,27</sup> and wood-based pasture systems combining multifunctional agriculture as agritourism<sup>28</sup> – relating the value of the cultural services to historic places, cultural gatherings, hospitality for tourists, recreational activities and components of local identity. However, under Indian conditions, understanding of agroforestry landscapes from the CES perspective is still lacking. Overall, people are positive towards nature in general, rather than in a specific landscape<sup>29</sup>. Our results confirm this because none of the participants had negative associations, even when considering 21% of the less-educated respondents, and most of them were willing to visit MFA frequently, indicating respect for the landscape.

Payment for environmental services is gaining global attention as a policy initiative and translates external ecosystem values into real financial incentives for local providers<sup>30</sup>. The present study shows the relationship between income and WTP, i.e. as income increases WTP increases. Income has a strong positive effect on WTP of the respondents to support the cultural services of an MFA. This notion has been reported in other studies as well<sup>31,32</sup>. The average amount that the respondents were willing to pay in this study was Rs 33/visit and few respondents suggested their willing to pay as an entrance fee. This has also been discussed in other studies<sup>33,34</sup>. Holistically, education had a significant influence on WTP decisions. The current study has some limitations with respect to determining local user groups in the MFA. Also, the models replicated in other regions are still in the early stages of development and cannot be compared. Therefore, it is necessary to broaden the scope of this study, where more opinions can be gathered and analysed in an integrated manner, as indicated by Brown and Fagerholm<sup>35</sup>. The findings of this study also emphasize the need to overcome the limitations mainly to highlight the local user groups or residents enjoying the cultural services.

## Conclusion

Several traditional agroforestry systems exist in India, but meagre efforts have been made to study agroforestry from a CES point of view. This is due to the importance given to profit-generation from other ecosystem services (provisioning and supporting services). In this study, education and income level of the respondents play a vital role in enjoying CES in MFA. Nevertheless, two perspectives have been identified from the results; (a) studying local personal motivation to acquire scientific information, and (b) obtain food and biomass provision as well as biodiversity and habitat.

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