Journal of Environmental Biology
p-ISSN: 0254-8704 • e-ISSN: 2394-0379 • CODEN: JEBIDP

JEB®

Original Research Paper
Volume 45 Issue 6 November 2024 pp. 676-685
DOI: http://doi.org/10.22438/jeb/45/6/MRN-5330

J. Environ. Biol., 2024
© Triveni Enterprises, Lucknow (India)
Journal website : www.jeb.co.in ★ E-mail : editor@jeb.co.in

Contribution of provisioning ecosystem services of homestead trees to rural livelihoods in Kashmir Himalaya, India

M.A. Islam*, A.A. Wani, A.A. Gatoo, M. Shah, K.A. Sofi, G.M. Bhat, A.A. Parrey and T. Arjumand

Division of Natural Resource Management, Faculty of Forestry, SKUAST-K, Ganderbal-191 201, India

Received: 08 April 2024 **Revised:** 07 June 2024 **Accepted:** 21 August 2024

***Corresponding Author Email :** ajaztata@gmail.com ***ORCiD:** https://orcid.org/0000-0002-4081-9120

Abstract

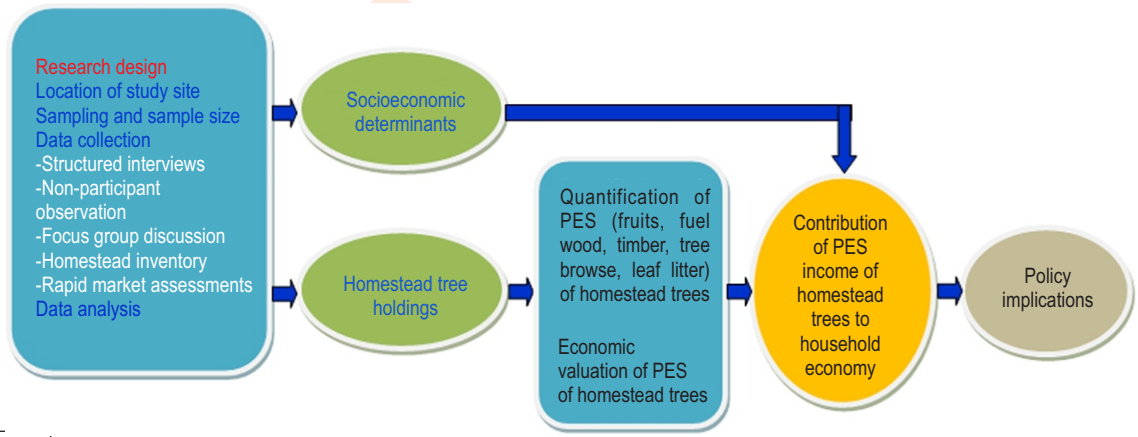
Aim: To quantify provisioning ecosystem services (PES) derived from homestead trees, estimate their economic value and contribution to rural livelihoods, and ascertain socio-economic determinants of household PES income from homestead trees in district Budgam of Kashmir.

Methodology: In this study 106 homesteads were selected across 12 sample villages using multi-stage random sampling. Data were gathered through structured interviews, focus group discussions, homestead inventories, non-participant observations, and rapid market assessments. The data were analyzed through descriptive and analytical statistics.

Results: The mean value of PES of homestead trees was ₹ 14349.27 per household per year, which was composed of fruits (45.54%), fuel wood (20.50%), tree browse (18.15%), timber (8.06%), and wicker (7.75%). PES of homestead trees constituted 4th important component of rural economy, accounting 16.23% of the average household's income. ANCOVA indicated that social membership, family size, family labour, farm size, livestock holding, main occupation, wealth status and annual income were potent predictors of household PES income from homestead trees. The R^2 (0.872) of the ANCOVA model indicated that socio-economic determinants accounted for 87.20% of the variation in homestead trees' domestic PES revenue.

Interpretation: Findings suggested that PES income from homestead trees is a vital intervention for socio-economic development, livelihood diversification, and forest conservation; hence, policy must be implicated towards a sustainable supply of PES from homestead trees by promoting homestead tree holdings.

Key words: Homestead trees, Kashmir Himalaya, Livelihood, Provisioning ecosystem services



Triveni Enterprises (Educational Services Set-up)

How to cite: Islam, M.A., A.A. Wani, A.A. Gatoo, M. Shah, K.A. Sofi, G.M. Bhat, A.A. Parrey and T. Arjumand: Contribution of provisioning ecosystem services of homestead trees to rural livelihoods in Kashmir Himalaya, India. *J. Environ. Biol.*, **45,** 676-685 (2024).

Introduction

Ecosystem services are intangible and tangible benefits that human society receives from ecosystems for people's well-being, either directly or indirectly (Kimaro *et al.,* 2024). Forests are considered fundamental sources of ecosystem services, securing provisioning services, supporting services, regulating services, and cultural services for the people (Yasin *et al.,* 2018). Rural people around the world have relied on forest provisioning ecosystem services (PES) for livelihood security, socio-economic well-being, and indeed survival from time immemorial (George and Christopher, 2020). Forest PES are constantly under threat or degradation due to excessive anthropogenic pressure, faulty land use and cover change, unsustainable management systems, deforestation, biodiversity loss, and global climate change (Yeasmin *et al.,* 2021). Trees outside forests (TOFs) on wastelands, community lands, agricultural lands, horticultural fields, homesteads, etc. provide the same PES as forests but remain untraced (Haque *et al.,* 2018). Over the last decade, a multitude of studies across the world on PES have focused on homestead forestry and examined ways to upgrade ecosystem services at higher scales, associated policy measures, and related issues in decision-making (Ruba and Talucder, 2023; Kimaro *et al.,* 2024).

Basically, homestead forestry is the most sustainable and resilient ecosystem, but studies focusing on tree-mediated PES and strategic tree management for ecosystem service provisions are lacking (Devi and Das, 2013). Homestead trees provide PES such as fuel wood, fodder, timber, fibre, floss, fruits, vegetables, herbal medicines, industrial feedstock, leaf litter, and other non-timber forest products (NTFPs) for livelihood security and income diversification, besides other regulating services (e.g., carbon sequestration, soil and water conservation, erosion control, biodiversity conservation, climatic moderation, etc.), cultural services (e.g., spiritual and religious values, indigenous traditional knowledge (ITKs), aesthetic values, human health, etc.), and supporting services (e.g., pollination, nutrient recycling, photosynthesis, etc.) (Ruba and Talucder, 2023). Homestead tree planting and maintenance for forest resource production to satisfy the socio-economic, environmental, psychological and cultural aspirations of rural people have been promoted by several international agencies (Eshetu *et al.,* 2018). Tree planting at homesteads has also been considered as a potential means of food and nutritional security, health care, bio-energy feedstock, livestock feed, housing materials, agricultural implements and tools, fertilizers, and composts, etc. (Yeasmin *et al.,* 2021).

Homestead tree planting for PES provisions for subsistence, cash, and safety-net among the rural people is an ancient farming practice in Kashmir (Saleem *et al.,* 2021). Kashmiri homesteads are characterized by multi-storied and multi-localized vegetation arranged vertically and horizontally by forest trees, fruit trees, shrubs, herbs, lianas, agricultural crops, livestock, and other allied components within the house compounds (Bhat *et al.,* 2019; Islam *et al.,* 2021). Indeed, homestead tree planting is considered a small-scale enterprise, and all the tree management practices are performed by household members, particularly women (Islam *et al.,* 2022). In rural Kashmir, homestead trees are increasingly recognized as the potential source of fuel, fodder, timber, housing materials, fruit, vegetables, shelter, medicines, floss, fertilizer, fibre, oilseed, cottage industries, handicrafts, employment, revenue, and other NTFPs (Saleem *et al.,* 2021). The diversity, dominance, and growing stock of homestead tree holdings correspond to the socio-economic conditions of the people and the biophysical backgrounds of the landscape (Islam *et al.,* 2021). Homestead tree planting in Kashmir represents the wisdom of socio-culture and indigenous ecological insights developed over the years and transferred from generation to generation (Saleem *et al.,* 2021).

Quantification and valuation of forestry PES is probably the best instrument to strengthen livelihood security, biodiversity conservation, and mitigation of climate change (Obeng *et al.,* 2020). PES valuation quantifies the benefits derived from ecosystems, estimates their monetary value, and assesses the impact of ecosystem services on people's well-being (Reang *et al.,* 2022). Economic valuation of PES is essential for decision-making processes in considering the economic choices, cost-effectiveness of an investment, trade-offs between different ecosystem management options, liability for damage to the environment, and socio-economic contribution of ecosystem services (Liu *et al.,* 2023). Valuing the PES of homestead trees and incorporating these values into developmental schemes have drawn much interest in recent research and literature (Obeng *et al.,* 2020). Numerous studies on the PES valuation of homestead trees and the socio-economic impact of PES have been conducted worldwide (Liu *et al.,* 2023), and policy perspectives have been proposed for future planning (Obeng *et al.,* 2020).

Though PES of homestead trees are extremely important, policymakers view them as a low-priority source of livelihood; therefore, their contribution to socio-economic development in rural Kashmir has been largely overlooked. While previous studies (Bhat *et al.,* 2019; Saleem *et al.,* 2021; Islam *et al.,* 2022) have broadened our understanding of several aspects of homesteads, empirical research on the economic valuation of PES of homestead trees is still an essential research area to be addressed. In this context, the current investigation was conducted to quantify the supplies of PES from homestead trees, assess their economic value and contribution to rural livelihoods, and determine the socio-economic factors influencing the PES income derived from homestead trees for policy implications and sustainable development in Kashmir Himalaya.

Materials and Methods

Study area: The study was carried out in the district Budgam, Jammu and Kashmir UT, located within the longitudes 74°24'2.69"-74°55'20.25" East and latitudes 33°48'42.79"-34°52'2.56" North at an altitude of 1610 m amsl (Fig. 1). Budgam district covers an area of 1370 km^2, and the land possesses undulating terrain alternating with mountains, valleys, and plains.

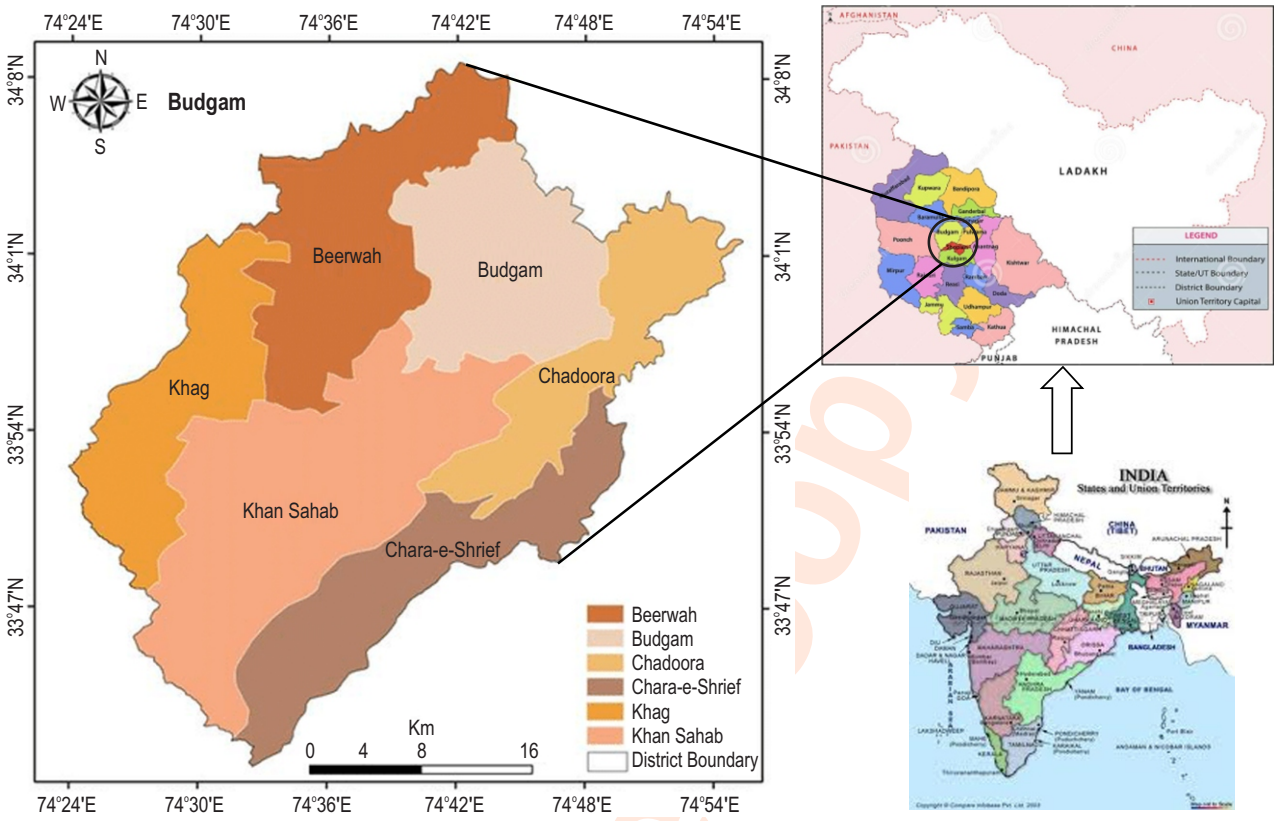


Fig. 1: Budgam district map showing the study areas.

The population of the district is 735753, with a density of 537 km^2, a sex ratio of 883 women per 1000 men and a literacy rate of 57.98% (Census of India, 2011). Agriculture, horticulture, livestock rearing, forest resources, wage earning, and petty trade are the major livelihood mainstays of local people. The main land uses in the district include cultivated land, forests, residential and non-farm land, unproductive and barren land, grasslands and pastures, cultivable waste land, fallows, and tree groves (Analytical Report, 2020). Forest cover accounts for 477 km^2 (34.79%) of the total geographical area, predominantly covered by the Himalayan Dry Temperate Forest (13/C) (Champion and Seth, 1968). The area experiences temperate monsoon type climate, with an average maximum temperature of 29.80ºC in summer, an average minimum temperature of -1.92ºC in winter, and an annual rainfall of 704 mm.

Design and sampling: This study employed a multi-stage random sampling technique, as described by Ray and Mondol (2011), to select households, villages and blocks (Table 1). In the 1st stage, five blocks, namely Narbal, Pakherpora, Nagam, Ratsun and Waterhail were selected. In the 2nd stage, twelve sample villages were selected, including three villages each from Narbal block (Kawoosa-jagir, Rakhi-Arath, and Nowpora) and Nagam block (Chowdrigund, Showpora, and Wampora), and two villages each from Pakherpora block (Shankarpora and Karapora), Ratsun block (Radbugh and Dragger), and Waterhail block (Udroo and Brail). In the 3rd stage, as a whole, 106 households were withdrawn as a representative sample from the study villages with 10% sampling intensity.

Data collection: Data from the sampled households were gathered through structured interviews, non-participant observation, focus group discussion (Mangal and Mangal, 2020), homestead inventory (Devi and Das, 2013), and rapid market assessments (Eshetu *et al.,* 2018). The interview schedule was structured to record data pertaining to household socio-economic traits, the quantity of PES of homestead trees produced, consumed and traded, and household income from various sources. Non-participant observations were conducted to have personal on-the-scenes interactions with the respondents, work together and examine the behaviour in a natural situation. Focus group discussions (FGDs) were conducted with 8–12 participants who were knowledgeable, interested, and able to converse in public. FGD is the perception analysis tool used to cross-check and validate the generated data. Homestead inventories were conducted to collect the data on homestead characteristics, tree diversity and growth statistics. Using diameter tapes, the diameter at breast height (dbh) of homestead trees was

Table 1: The sampling frame and sample size

Blocks	Villages	Sampling frame	Sampling intensity	Sample size
Narbal	Kawoosa-jagir	55	0.10	6
	Rakhi-Arath	63	0.10	6
	Nowpora	92	0.10	9
Pakherpora	Shankarpora	119	0.10	12
	Karapora	85	0.10	9
Nagam	Chowdrigund	76	0.10	8
	Showpora	90	0.10	9
	Wampora	91	0.10	9
Ratsun	Radbugh	96	0.10	10
	Dragger	51	0.10	5
Waterhail	Udroo	138	0.10	13
	Brail	100	0.10	10
5	12	1056	0.10	106

measured 1.37 m above ground. Clinometers were used to measure the trees' total height. The formula V = (π x dbh^2 x H x 0.5)/40000 was used to determine the volume for each tree, where H is tree height (m), dbh is diameter at breast height (cm), and V is volume of tree bole (m^3). For each tree, a form factor of 0.5 was used to account for the tapering effect of diameter and height measurements on tree volume (Eshetu *et al.,* 2018). Rapid market assessment of PES of homestead trees was conducted to understand the market dynamics and trade mechanisms of potential PESs, the economic valuation of PES of homestead trees, and the relative contribution of PES of homestead trees to domestic economy.

Income accounting: PES income (₹/household/year) was estimated as follows:

$$Income_{PES} = \sum_{(i=1)}^{n} Qi\ X\ Pi$$

Where, $Income_{PES}$ is the value of PES sources, Q*i*= quantity of ith PES (kg), P*i*= price of ith PES (₹ kg^{-1}) and *i*= number of PES

Household annual income (₹/household/year) was calculated follows:

$$Income_t = \sum_{(i=1)}^{n} Xi$$

Where, $Income_t$ is total income earned from all sources, X*i*= revenue from ith source of revenue and *i*= number of income source

Data analysis: Both analytical and descriptive statistics were used to analyze the data. Descriptive statistics, including frequency (f), percentage (%), average (x), standard deviation, and range (Snedecor and Cochran, 1967) were used to summarize the socio-economic variables, homestead characteristics, tree growth statistics, and the absolute and relative contribution of PES income of homestead trees to households' income. An analysis of covariance (ANCOVA) was employed to ascertain the influence of socio-economic variables on the PES income of homestead trees. MS Excel and SPSS computer software were used to process and analyse the data.

Results and Discussion

Household socio-economic profiles: The socio-economic traits (Table 2) indicated that a majority of household heads were middle-aged (M=41.61, SD=10.91), had low literacy up to primary level (M=1.75, SD=1.54), were members of only one organization (M=1.41, SD=0.82), belonged to large families (M=1.69, SD = 0.41), and had family labour of 3 workers (M=3.09, SD=0.92). The majority of households had marginal farms (M=1.09, SD = 0.30) with 6 to 10 livestock (M=2.33, SD=1.77), engaged mainly in cultivation (M=3.33, SD = 1.01), belonged to medium wealth status (M=1.33, SD = 0.72), and earned an average income of ₹ 95921.73 per year, ranging from ₹ 25000 to 120000 per year.

Rural households' socio-economic characteristics are crucial factors that significantly influence the determination of homestead ownership, tree farming strategies, and perceptions towards PESs of trees (Anastase and Nahayo, 2020; Prabawani *et al.*, 2024). They are the key attributes directly associated with homestead tree abundance and diversity, diverse use patterns, tree-based livelihoods, and poverty-tree use interactions (Koussihouede *et al.,* 2019; Prabawani *et al.,* 2024). They are the determinants of supplies of PES from homestead trees, subsistence consumption, trade for cash income, and safety nets (Yasin *et al.,* 2018). The favourable socio-economic settings catalyse resolving forest depletion and degradation, biodiversity conservation, and ecosystem services of forest resources among rural communities (Shukla *et al.,* 2020; Prabawani *et al.,* 2024). According to Turdieva *et al.* (2024), higher levels of managed tree diversity have been found in Central Asia due to more favourable socio-economic conditions than unfavourable ones. The findings reflected that the existing socio-economic conditions of the homestead owners are far from ideal, and hence it is necessary to

Online Copy

Table 2: Socio-economic variables of homestead owners (N=106)

Variables	Explanation	Measurement description	Mean	Std. Dev.	Minimum	Maximum
Age	Age of head of household in years	Number of years that respondent has lived	41.61	10.91	24	76
Education	Household head completed education	0=illiterate, 1=<primary, 2=primary, 3=middle, 4=high school, 5=intermediate, 6=graduate & over	1.75	1.54	0	6
Social membership	Membership of household head in organizations	0=no membership, 1=membership of 1 organization, 2=membership of >1 organization, 3=office bearer, 4= public leader	1.41	0.82	0	4
Family size	No. of members in a household	1=< 5 members, 2=>5 members	1.69	0.41	1	2
Family labour	No. of working members in a household	1=1 worker, 2=2 workers, 3=3 workers, 4=>3 workers	3.09	0.92	1	4
Farm size	Land area owned by household	0=landless, 1=marginal (upto 1.0 ha), 2=small (1.1 to 2.0 ha), 3=medium (2.1 to 4.0 ha), 4=large (> 4.0 ha)	1.09	0.30	1	4
Livestock holding	Number of cattle that the household owns	0=no livestock, 1=<5 livestock, 2=6 to 10 livestock, 3=>10 livestock	2.33	1.77	1	3
Main occupation	An occupation in which a person works for six months or longer each year	1=wage labour, 2=caste profession, 3=cultivation, 4=business, 5= service, 6=any other	3.33	1.01	1	6
Wealth status	The relative wealth status of the households within the community / physical assets	0=poor, 1=medium, 2=rich	1.33	0.72	0	2
Annual income	Total household income from both on- and off-farm sources	₹/year	95921.73	87319.09	25000.00	120000.00

Table 3: Homestead tree holdings by the owners (N=106)

Parameters	Range	Mean±S.D.
Homestead size (ha)	0.026-0.47	0.163±0.4
Tree holdings (no./homestead)	21.67-391.67	135.83±9.8
Tree diameter (cm)	4.22-43.56	24.45±2.3
Tree height (m)	3.12-25.48	17.64±2.6
Basal area (m^2/homestead)	0.030-58.34	6.37±1.4
Volume (m^3/homestead)	0.095-1186.50	112.44±8.6
Tree area under homesteads (%)	15.54-67.36	20.64 ±3.4
Species	-	32
Genera	-	20
Families	-	12

enhance their standard of living by diversifying their livelihoods through PES of homestead trees. The valid characterization of sample households' socio-economic variables demonstrated in this investigation could be a confounding factor in homestead planning, tree resource management, and diversifying tree-based economy.

Homestead tree holdings: Among the 106 homesteads sampled, the size ranged from 0.026 to 0.47 ha with an average of 0.163 ha, and the average tree holding per homestead was 135.83, ranging from 21.67 to 391.67. The homestead tree growth statistics showed that the average tree diameter was 24.45 cm, ranging from 4.2 to 23.56 cm, the average tree height was 17.64 m, ranging from 3.12 to 25.48 m, the mean tree basal area per homestead was 6.37 m^2 with a range of 0.030-58.34 m^2, and the average tree volume per homestead ranged from 0.095 to 1186.50 m^3, with an average of 112.44 m^3. About 32 different tree species, representing 20 genera and 12 families, were found in the surveyed homesteads (Table 3).

Almost all the households' owned a homestead adjacent to their home, demarcated by concrete walls, wood poles or live fences. All homesteads had abundant trees, distributed in several distinct strata according to the age and size of the species. The vertical stratification and horizontal zonation of trees varied from homestead to homestead due to the homestead owner's species

Online Copy

Table 4: Quantification and valuation of PES of homestead trees (N=106)

PES	Quantity (kg/hh/year) of PESs accessed			Economic value (₹/hh/year) of PES			Income share (%)
	Subsistence	Cash	Total	Subsistence	Cash	Total	
Fruits	451.32	340.22	791.54	8998.79	6814.18	15812.97	45.54
Fuel wood	910.56	273.67	1184.23	5475.26	1642.07	7117.33	20.50
Timber	0.18$^{\Delta}$	0.135$^{\Delta}$	0.315$^{\Delta}$	1600.00	1200.00	2800.00	8.06
Tree browse	712.28	334.46	1046.74	4297.35	2004.34	6301.69	18.15
Wicker	0.00	21.52	21.52	0.00	2688.67	2688.67	7.75
Leaf litter	506.36	0.00	506.36	0.00	0.00	0.00	0.00
Total	-	-	-	20371.40	14349.26	34720.66	100.00

Note: hh= household; $\Delta = m^3$

preference, management practices, and choice of tree-crop combination. The PES of homestead trees were used under twelve different use categories, including browse, fuel wood, vegetable, medicines, ornamental, edible fruit, timber, fencing materials, cottage industry, wicker, leaf litter and edible seed. The tree vegetation in the homesteads is dominated by three different canopy layers, viz., the emergent layer (≥ 15 m), main canopy (10-15 m), and understory (5-10 m). The study confirms earlier findings (Devi and Das, 2013; Haque *et al.,* 2018; George and Christopher, 2020) that homesteads are potential units for conservation of tree biodiversity and resource management through efficiently utilizing household landscapes. The ecological parameters of the homesteads in Kashmir were similar to the homesteads previously documented (Reang *et al.,* 2022). The sustainable management of homestead tree resources depends greatly on indigenous traditional ecological knowledge accumulated over generations by their ancestors (Ruba and Talucder, 2023).

Quantification of PES of homestead trees: The average quantities of PESs (Table 4) extracted from the homestead trees in the surveyed households were fuel wood, 1184.23 kg/year (subsistence = 910.56 kg/year; trade = 273.67 kg/year), tree browse, 1046.74 kg/year (subsistence = 712.28 kg/year; trade = 334.46 kg/year), timber, 0.315 m^3/year (subsistence = 0.18 m^3/ year; trade = 0.135 m^3/ year), wicker, 21.52 kg/year (subsistence = 0.00 kg/year; trade = 21.52 kg/year), fruits, 791.54 kg/year (subsistence = 451.32 kg/year; trade = 340.22 kg/year), and leaf litter, 506.36 kg/year (subsistence = 506.36 kg/year; trade = 0.00 kg/year).

Homestead tree planting and management is an age-old land-use strategy for deriving PES from household trees in rural Kashmir. The PES of homestead trees is primarily harvested for household subsistence consumption, income earnings, and safety nets. The major PES of homestead trees extracted include fruits, wicker, tree browse, fuel wood, timber and leaf litter (Fig. 2) essential for household livelihoods. Fruit cultivation on homesteads is a specific tree-based livelihood activity in the surveyed population because fruits are essential for food and nutritional security. In fact, wickers being a much-valued tree product for wicker handicraft entrepreneurship, the production and collection of withies from the homestead trees have been reported as an important part of their traditional farming activities. Since livestock production is an essential subsidiary occupation and a component of sampled households' farming system, the homestead production of tree browse is indispensable for fodder security. Fuel wood is a primary energy source for most sample households because of the scarcity of economic substitutes for energy sources; hence, fuel wood harvesting from homestead trees has become a common tree-based livelihood activity. The rotational extraction of timber from homestead trees is a common practice in rural households, primarily for building and repairing homes, farming implement, rural furniture, huts and fences, scaffolding, poles, props, etc. The collection of leaf litter by the women from the homestead trees is customary for compost preparation for nutrient cycling, enhanced crop productivity, charcoal making to counter the harsh winters, and flooring the cattle sheds for livestock protection. Numerous studies (Anastase and Nahayo, 2020; George and Christopher, 2020; Islam *et al.,* 2021; Baul *et al.,* 2022) have shown that production and consumption of PES from homestead trees is a major tree-based livelihood source around the world.

Economic valuation of PES of homestead trees: The mean economic value of PES derived from homestead trees was ₹ 34720.66/household/year, including subsistence (₹ 20371.40/household/year) and trade (₹ 14349.26/household/ year). Fruits contributed highest (45.54%) to the mean annual value of PESs derived from homestead trees, followed by fuel wood (20.50%), tree browse (18.15%), timber (8.06%) and wicker (7.75%) (Table 4). The extraction and sale of PES from homestead trees is a conventional income-generating activity for rural families in the Kashmir Himalaya. Harvesting fruits, wicker, tree browse, timber and fuel wood from the homestead trees was reported as a chief source of tree-related income for rural families. The study found that the sample households collected and sold a sizable quantity of PES from homestead trees, which generated a handsome return to the sellers. The PES of homestead trees has an emerging and growing market demand; hence, the people have substantial marketing opportunities in nearby local and regional markets for their delivery. The PES of homestead trees

Online Copy

(a) Fuel wood (b) Tree browse (c) Timber

(d) Fruit (e) Wicker (f) Leaf litter

Fig. 2: PES derived from homestead trees.

Table 5: Income portfolios and contribution of PES income of homestead trees to household incomes (N=106)

Source of income	Total income (lakh ₹/year)	Mean income (₹/hh/year)	Std. Dev.	Income share (%)
PES of homestead trees	15.21	14349.26	4888.09	16.23
Agricultural crops	31.16	29396.58	9998.86	33.24
Livestock husbandry	16.35	15431.97	5443.69	17.45
Off-farm	31.00	29247.65	9978.27	33.08
Total	93.73	88425.47	-	100.00

hh= house hold

were generally marketed unprocessed, as no specialized processing techniques or value-added measures were observed in the study. This supports a previous study (Baul *et al.,* 2022), which reported that the PES of homestead trees contributes significantly to securing household livelihoods through cash income and subsistence. Several studies (Haque *et al.,* 2018; Islam *et al.,* 2021; Kimaro *et al.,* 2024) have shown that the PES of homestead trees plays a potential role in meeting food, livelihood and health security needs, besides earning revenue and safety nets.

Contribution of PES cash income of homestead trees to household economy: The results (Table 5) revealed that total revenue earned from all the off-farm and on-farm sources was ₹ 93.73 lakh/year, averaging ₹ 88425.47/household/year in the population surveyed. Of the household total income, agricultural crops contributed the largest share (33.24%), followed by off-farm sources (33.08%), livestock husbandry (17.45%) and PES of homestead trees (16.23%). This finding implies that PES of homestead trees constitute the 4th most important component of rural households' economies. Agriculture is primary occupation of rural population and the backbone of the rural economy. Many respondents either belonged to agricultural families or were reliant on farming-based livelihoods; hence, agricultural crops generated the largest share of household income. A considerable proportion of people derived their income from non-farm sources, primarily from wage labour, petty business, caste occupation, service, handicraft, cottage industries, and other allied activities that contribute a sizeable share to household income.

Livestock husbandry has a significant contribution to household income because holding livestock is the most important secondary occupation to support agriculture and associated activities, besides food and nourishment, socioeconomic, religious and recreational benefits. The PES of

Table 6: Influence of socioeconomic variables on household PES income derived from homestead trees (N=106) (ANCOVA)

Source	Type III sum of squares	df	Mean square	F-ratio	p-value
Corrected model	36790000.00a	10	3678765.12	64.48**	0.000
Intercept	212600000.00	1	212600000.00	3726.07**	0.000
Age	22874.08	1	22874.08	0.40*	0.528
Education	698306.72	1	698306.72	12.24**	0.001
Social membership	34918.83	1	34918.83	2.61**	0.036
Family size	228639.92	1	228639.92	4.01**	0.048
Family labour	1431614.57	1	1431614.57	25.09**	0.000
Farm size	583094.34	1	583094.34	10.22**	0.002
Livestock holding	3327268.66	1	3327268.66	58.32**	0.000
Main occupation	257084.97	1	257084.97	4.50**	0.036
Wealth status	1321890.26	1	1321890.26	23.17**	0.000
Annual income	232114.11	1	232114.11	4.06**	0.047
Error	5419404.81	95	57046.36		
Total	21870000000.00	106			
Corrected total	42210000.00	105			

[a]R Squared= 0.872 (Adjusted R Squared= 0.858); *= non-significant at ≤5% level; **= significant at ≤5% level

homestead trees was viewed as a viable means of monetary revenue and subsistence, contributing substantially to total household income. Although the PES of homestead trees is a supplementary livelihood source, it is supportive, and despite the limited financial gain, tree farming is a crucial source of independence, pride and self-esteem. Previous investigations (Eshetu *et al.,* 2018; Haque *et al.,* 2018; Anastase and Nahayo, 2020; Shukla *et al.,* 2020; Islam *et al.,* 2021; Baul *et al.,* 2022; Reang *et al.,* 2022) have reported significant contributions of PES from homestead trees to the household economy.

Socio-economic variables influencing PES cash income of homestead trees: The ANCOVA showed that among the explanatory variables, education (F=12.24, p=0.000), social membership (F=2.61, p=0.036), family size (F=4.01, p=0.048), family labour (F=25.09, p=0.000), farm size (F=10.22, p=0.002), livestock holding (F=58.32, p=0.000), main occupation (F=4.50, p=0.036), wealth status (F=23.17, p=0.000) and annual income (F=4.06, p=0.047) had a highly significant impact on household PES income derived from homestead trees (Table 6). However, age had a non-significant effect on household PES income derived from homestead trees (F=0.40, p=0.528). The total amount of variation explained (SST) was 42210000.00, of which the experimental manipulation accounted for 36790000.00 units (SSM), while 5419404.81 units were unexplained (SS_R).

The R^2 (0.872) of this model designated that 87.20% of the variation in the domestic PES income of homestead trees is explained by socio-economic variables. The significant impact of education on the PES income of homestead trees confirms that the educational background directly influences the nature of economic activity and income level. Education helps people comprehend the challenges, prospects, internal factors, and external issues of homestead tree planting (Koussihouede *et al.,* 2019). Further, education is a significant factor in creating awareness, improvement of technical know-how, decision-making and motivation towards creating PESs from homestead trees. The significant impact of social participation on PES income of homestead trees could be clarified by the concept that social involvement helps the members to communicate their opinions and experiences to other members of the society, clarify their doubts, get opinions and enrich their knowledge (Islam *et al.,* 2022). The family size has a direct effect on the quantity of PES derived from homestead trees (Prabawani *et al.,* 2024). This implies that the larger families produce and harvest more homestead tree PESs than others with smaller families. Families with a larger labour force have a higher probability of exploiting PES of homestead trees due to availability of family labour utilized for their management, harvesting and marketing (Turdieva *et al.,* 2024).

Households with larger farm land have a higher probability of involvement in tree farming activities, which is quite evident as more land holdings mean more PES from homestead trees, and therefore more income (Yasin *et al.,* 2018). The livestock holding has a substantial influence on the PES income of homestead trees, which implies that as livestock numbers increase, dependency on the PES of homestead trees will also increase because these resources are indispensable to livestock rearing (George and Christopher, 2020). Annual income, wealth status and primary occupation are other important financial factors that significantly affect the PES income of homestead trees, which could be explained by the views that these economic variables secure capital, assets, and inputs for homestead tree farming and subsequent tree resource-based incomes (Islam *et al.,* 2022).

The non-significant effect of age on the PES income earned from homestead trees implies that individuals from every age group, whether old, middle or young are equally involved in homestead tree farming and allied activities. The household

Online copy

characteristics determine the homestead tree holdings (Devi and Das, 2013; Islam *et al.,* 2021;Turdieva *et al.,* 2024) and are vital predictors of PES income derived from homestead trees (Koussihouede *et al.,* 2019; Ruba and Talucder, 2023).

Homestead trees provide rural people with multiple PESs for livelihood security, including monetary income, a safety net, and subsistence in Budgam district in Kashmir. The PES derived from homestead trees supports food security, livestock production, bio-energy security, agricultural support, housing, cottage industry, health care, socio-culture, income generation, and employment opportunities. Since the income earned from PES of homestead trees is a significant contributor to the household economy, planning a livelihood diversification strategy through the PES of homestead trees should be considered a crucial intervention for poverty reduction and socio-economic development. Such initiatives will largely contribute to the homesteading of forest trees, the production of homestead tree PESs, and rural entrepreneurship, besides other ecosystem services like cultural, regulating and supporting. The planners should consider the socio-economic factors that lead to the higher PES income from homestead trees for the successful conversion of subsistence-oriented homesteads into commercial ones. The study's objectivity is restricted to respondents' comprehension, memory, and verbal expression of necessary information as well as to the social, psychological, temperamental, and biophysical characteristics influencing human behaviour. The fluctuations in the market prices of PES derived from homestead trees may have affected the precision of the results.

Acknowledgments

The authors are grateful to the homestead owners for permitting them to conduct the survey and for providing research data. Special thanks are due to the government officers, key informants, village heads, and local leaders for their invaluable cooperation and guidance in the fieldwork.

Authors' contribution: M.A. Islam: Design and implementation of experiment, data analysis, and writing manuscript; **A.A. Wani:** Supervision of research work; **A.A. Gatoo:** Field survey and data collection; **Murtaza Shah:** Data feeding and processing; **K.A. Sofi:** Management and coordination of the research activities; **G.M. Bhat:** Editing and improvement of the manuscript. **A.A. Parrey:** Execution and rapport building; **T. Arjumand:** Literature survey.

Funding: Division of Natural Resource Management (NRM), Faculty of Forestry, SKUAST-K, Benhama, Ganderbal, J&K, India.

Research content: The research content of the manuscript is novel and has not been published anywhere.

Ethical approval: Approved by the Ethics Committee of the SKUAST-Kashmir, Shalimar, Srinagar, J&K, India.

Conflict of interest: The authors claim that they have no conflicting interests.

Data availability: Not applicable.

Consent to publish: All authors agreed to the publication of the paper in the *Journal of Environmental Biology.*

References

Analytical Report, District Statistical Handbook, Directorate of Economics and Statistics, District Statistics and Evaluation Office, Budgam, Jammu and Kashmir, pp. 23-67 (2020).

Anastase, G.M. and L. Nahayo: Impact assessment of agroforestry practices on community socio-economic livelihoods in Rwanda. *Int. J. Environ. Agric. Res.*, **6**, 59-71 (2020).

Baul, T.K., T.A. Peuly, R. Nandi, S. Kar and S. Karmakar: Role of homestead forests in adaptation to climate change: A study on households' perceptions and relevant factors in Bandarban Hill District, Bangladesh. *Environ. Manage.,* **69**, 906-918 (2022).

Bhat, G.M., M.A. Islam, A.R. Malik, T.A. Rather, F.A. Shah Khan and A.H. Mir: Productivity and economic evaluation of Willow (*Salix alba* L.) based silvopastoral agroforestry system in Kashmir valley. *J. Nat. Appl. Sci.,* **11**, 743-751 (2019).

Census of India, Primary Census Abstract (PCA), District Census Handbook Badgam, Directorate of Census Operations, Jammu & Kashmir, Series-02, Part XII-B, pp. 16-131 (2011).

Champion, H.G. and S.K. Seth: Revised survey of forest types in India. Manager of Publication, FRI Press, Dehra Dun, pp. 325-326 (1968).

Devi, N.L. and A.K. Das: Diversity and utilization of tree species in Meitei homegardens of Barak Valley, Assam. *J. Environ. Biol.,* **34**, 211-217 (2013).

Eshetu, S.B., J. Pretzsch and T.B. Mekonnen: Financial analysis of smallholder farmers woodlot and homestead agroforestry systems and its implications for household income improvement, the case of Hawassa Zuria District, Southern Ethiopia. *J. Agri. Sci. Food Res.,* **9**, 1-7 (2018).

George, M.V. and G. Christopher: Structure, diversity and utilization of plant species in tribal homegardens of Kerala. *India. Agrofor. Syst.,* **94**, 297–307 (2020).

Haque, M.A., N. Naher and T. Sultana: Homestead tree species diversity and its impact on the livelihood of the farmers in Bangladesh. Int. *J. Agric. Environ. Food Sci.,* **2**, 148-154 (2018).

Islam, M.A., A.A. Wani, G.M. Bhat, A.A. Gatoo, Murtaza Shah, K. Anjum and U. Atta: Homestead tree resource production for rural livelihood security in Kashmir Himalaya. *Range Manag. Agrofor.,* **42**, 334-340 (2021).

Islam, M.A., P.A. Sofi, G.M. Bhat, A.A. Wani, Wani, Gatoo, A.R. Malik, N.A. Pala, S. Murtaza and K. Anjum: Household economic dependence on homegarden forest resources in Kashmir Himalaya, India. In: Diversity and Dynamics in Forest Ecosystems (Eds.: M. Kumar, N.A. Pala and J.A. Bhat). 1st Edn., Apple Academic Press Inc., Palm Bay, USA, pp. 351-370 (2022).

Kimaro, O.D., E. Desie and D.N. Kimaro, K. Vancampenhout and K.H. Feger: Salient features and ecosystem services of tree species in mountainous indigenous agroforestry systems of North-eastern Tanzania. *For. Glob. Change*, **7**, 1-19 (2024).

Koussihouede, H., C. Clermont-Dauphin, H. Aholoukpe, B. Barthes, L. Chapuis-Lardy, L. Jassogne and G. Amadji: Diversity and socio-economic aspects of oil palm agroforestry systems on the Allada plateau, southern Benin. *Agrofor. Syst.,* **94**, 41–56 (2019).

Online Copy

Liu, Q., K. Yan and Y. Yan: Evaluation of ecosystem service value of homegarden in chengdu plain and relevant protection strategy. *Forests,* **14**, 1754 (2023).

Mangal, S.K. and S. Mangal: Research Methodology in Behavioural Science. PHI Learning Private Limited. Delhi, India, pp. 304-314 (2020).

Obeng, E.A., B.D. Obiri, K.A. Oduro, S. Pentsil, L.C. Anglaaere, E.G. Foli and D.A. Ofori: Economic value of non-market ecosystem services derived from trees on cocoa farms. *Curr. Res. Environ. Sustain.,* **2**, 100019 (2020).

Prabawani, B., S.P. Hadi, M.R. Fisher, W. Hardi, R.S. Dewi and I. Ainuddin: Socio-economic perspective of agroforestry development in Central Java. *Environ. Sustain. Indic.,* **22**, 100354 (2024).

Ray, G.L. and S. Mondol: Research Methods in Social Sciences and Extension Education. Kalyani Publishers, New Delhi, pp. 66-76 (2011).

Reang, D., U.K. Sahoo, K. Giri, A. Hazarika and A.J. Nath: Ethnic homestead forests of North-east India revealed as diverse land-use systems. *Agrofor. Syst,* **96**, 465–478 (2022).

Ruba, U.B. and M.S.A. Talucder: Potentiality of homestead agroforestry for achieving sustainable development goals: Bangladesh perspectives. *Heliyon,* **9**, e14541 (2023)

Saleem, I., J.A. Mugloo, K.N. Qaisar, P.A. Khan, G.M. Bhat, M. Dar and A.A. Baba: Inventory and composition of prevalent agroforestry systems across Anantnag district of Jammu and Kashmir. *J. Eco-frien. Agricul.,* **16**, 146-150 (2021).

Shukla, H.O., A. Tomar, A. Kushwaha, R. Singh and A. Srivastav: Agroforestry practices in Ballia District of Eastern Plain Region of Uttar Pradesh, India. *Int. J. Environ. Agric. Res.,* **6**, 72-80 (2020).

Snedecor, G.W. and W.G. Cochran: Statistical Methods. Iowa State University Press, Ames, Iowa-50010, pp. 26-36 (1967).

Turdieva, M., A. Bernis-Fonteneau, M. Esenalieva, A. Kayimov, A. Saparmyradov, K. Safaraliev, K. Shalpykov, P. Colangelo and D.I. Jarvis: A regional perspective of socio-ecological predictors for fruit and nut tree varietal diversity maintained by farmer communities in Central Asia. *World,* **5**, 22–35 (2024).

Yasin, H., Z. Kebebew and K. Hundera: Woody species diversity, regeneration and socio-economic benefits under natural forest and adjacent coffee agroforests at Belete Forest, Southwest Ethiopia. *Ekológia (Bratislava),* **37**, 380–391 (2018).

Yeasmin, S., K.S. Islam, M. Jashimuddin and K.N. Islam: Ecosystem services valuation of homestead forests: A case study from Fatikchari, Bangladesh. *Environ. Challen.,* **5**, 1-8 (2021).

Online Copy